MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MICHIGAN

RADIATION ENVIRONMENTAL MONITORING

PROGRAM REPORT

SUPPLEMENT 3

2002-2004

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http://www.michigan.gov/deq
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Prepared by

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

Recognizing that the use of nuclear energy to produce electricity could have an adverse impact on public health and the environment, the state of Michigan established the Michigan Radiation Environmental Monitoring Program (MREMP) in 1958 to monitor the environs near the nuclear power plant sites to assure that Michigan's citizens and environment are not adversely impacted. Environmental samples in the form of air particulates, air vapors, milk, surface water, and direct radiation are taken from various sites in Michigan and analyzed to determine if any radiological effects due to nuclear power plants can be detected.

Historically, sample results from all media have indicated elevated levels of radioactivity, but the vast majority of these elevated levels are attributable to past atmospheric testing of nuclear weapons. Analytical results that could be attributed to nuclear power plant operations have only been detected on-site at the plants and were within the allowable U.S. Nuclear Regulatory Commission (NRC) limits. No analytical results attributable to nuclear power plant operations have been detected off site at any of the plants (see *MREMP Report 1958-1996, MREMP Report, Supplement 1, 1997-1999, and MREMP Report, Supplement 2, 2000-2001*).

This report (*MREMP Report, Supplement 3, 2002-2004*) contains the results of radiation environmental monitoring for the years 2002-2004, extending by three years the previously reported data published in 1998 (*MREMP Report 1958-1996), 2000 (MREMP Report, Supplement 1, 1997-1999*) and *2002 (MREMP Report, Supplement 2, 2000-2001)*. Although a few samples were found to contain elevated levels of radioactivity attributable to nuclear power plant operations, these samples were collected within the nuclear plant site property and did not represent a regulatory, public health, or environmental concern. The influence of atmospheric fallout from past testing of nuclear weapons can no longer be readily seen in environmental samples, and monitoring levels from all off-site samples now fluctuate in the range of natural background radiation.

In conclusion, the results of the MREMP for the years 2002-2004 indicate that no public health or environmental radiological impact has yet been detected in the off-site environs of Michigan's nuclear power plants due to the operation of nuclear power reactors.

INTRODUCTION

Program History

In 1958 the Michigan Department of Health established the Michigan Radiation Environmental Monitoring Program (MREMP) to determine the impact of nuclear power plants on the environment and public health. Specific statutory authority for an environmental monitoring program was provided to the Michigan Department of Public Health in 1972 with the enactment of 1972 PA 305. Later, the Public Health Code, 1978 PA 368, as amended (Act 368), provided this authority in Section 13518 of Part 135, Radiation Control, of Act 368. In April 1996 the MREMP was transferred to the Michigan Department of Environmental Quality (MDEQ) by Executive Order 1996-1, along with other radioactive material radiation protection programs. The MREMP monitoring program has been in continuous operation since its inception in 1958.

This report is the 3rd supplement to the *Michigan Radiation Environmental Monitoring Program (MREMP) Report 1958-1996* published in May 1998. The *MREMP Report Supplement 1 1997-1999* was published in August 2000, and Supplement 2 was published in August 2002, by the MDEQ. This third supplement extends the monitoring period that began in 1958 through the years 2002 and 2004. As a sequel, this supplement report will focus on the 2002-2004 monitoring results and refer to the original report for discussions of historical trends and preoperational baseline results.

Nuclear Power Plants in Michigan

Big Rock Point

Consumers Energy Company's Big Rock Point Plant, a boiling water reactor (BWR) near Charlevoix, was the first operational nuclear power plant in Michigan. The 240 megawatt thermal (MWt) plant achieved initial criticality on September 27, 1962, and commenced electrical power production before the end of the year. On August 29, 1997, which was the 35th anniversary of the Atomic Energy Commission issuance of an operating license to Big Rock Point, the plant was shut down for the final time. Site decommissioning activities were initiated shortly after the final shut down and will continue over the next several years, when the decommissioning and site restoration projects are completed. The Big Rock Point Plant has been under MREMP surveillance since July 1960.

Palisades

Located near South Haven, Michigan, is Consumers Energy Company's Palisades Plant, a 2530 MWt pressurized water reactor (PWR) that went into operation in 1971. The Palisades Plant has been in essentially continuous operation since 1971 except for two lengthy periods: one in the mid-1970s and another in the fall of 1990, when extensive steam generator repair and/or steam generator replacement took place. MREMP surveillance of the plant was initiated in 1968.

D. C. Cook

The American Electric Power Company's D. C. Cook Plant is a two-reactor facility located near Bridgman, Michigan. D. C. Cook I, a 3250 MWt PWR, commenced operation in early 1975 and has operated essentially continuously through September 1997. D. C. Cook II, a 3411 MWt PWR, commenced electrical power production in 1978 and, with the exception of a steam generator replacement in 1988, has operated essentially continuously through September 1997. American Electric Power Company shut down both reactors of the D. C. Cook Plant in September 1997 due to concerns raised regarding the long-term reliability of reactor and reactor containment cooling systems. Both reactors were restarted during 2000 (Unit II in June 2000 and Unit I in December 2000) following a refurbishment of each unit's ice condenser system and modifications to other plant safety systems. Both units have operated essentially continuously since their restart. MREMP surveillance of the D. C. Cook Plant was initiated in 1971.

Fermi 2

Fermi 2, Michigan's newest nuclear power plant, is located on the same site as was the original Enrico Fermi Nuclear Power Plant near Monroe, Michigan. The 3430 MWt BWR achieved initial criticality in June 1985 but, due to a variety of problems, did not start reliable electrical power production until November 1988. Fermi 2 experienced a routine operational history until Christmas Day in 1993, when a failure of one of the low pressure turbines caused major damage to the turbine and the main generator. After a 13-month outage to repair the damaged nonnuclear plant components and clean up the affected areas of the plant, the plant was once again operational and has been in routine power production mode ever since. Since the Fermi 2 Plant is adjacent to the Enrico Fermi Plant, MREMP surveillance of the plant was technically initiated in 1958. Monitoring at the plant site was scaled back in 1975, with the completion of the major portion of the original Enrico Fermi Plant decommissioning, and expanded in the fall of 1983 just prior to the scheduled initial date of operation for Fermi 2.

Environmental Monitoring Phases

The purpose of the MREMP is to assess the environmental impact from operating nuclear power plants in Michigan and to determine any public health impact that may be the result of plant operations. This program also provides verification of the plant operated effluent monitoring system for each nuclear plant, as well as its associated radiological environmental monitoring network, and also serves as an in-place sampling network in the event of an accidental release. Atmospheric, terrestrial, aquatic, and direct radiation pathways are monitored to determine the potential impact of nuclear power plant operations on the environment and public health.

Preoperational environmental samples are collected and analyzed to provide background data on natural radioactivity and/or man-made sources of radioactivity in the vicinity of a planned operational nuclear power plant. Data accumulated during the preoperational period establish a baseline with which to compare operational measurements. A minimum of one year of data is usually collected prior to reactor operation for an adequate preoperational monitoring program. For all four nuclear power plant sites in Michigan, at least two years of data were collected. In addition to the preoperational monitoring conducted in the environs of Michigan's four nuclear power plant sites, a background reference station is operated in Lansing, Michigan, for data comparison.

The operational phase of the radiological environmental monitoring program is a natural extension of the preoperational monitoring program. Once the reactor becomes operational, environmental samples are collected from the network of sampling sites established for the preoperational phase, and individual and cumulative measurement results are compared to baseline data to discern any trends that may be indicative of the impact of plant operations. Measurement results from each of the nuclear plant areas are also compared to the results from the Lansing reference station, as well as the results from the other plant environs to assure that data anomalies and/or trends are adequately assessed. The Palisades, D. C. Cook, and Fermi 2 Plants are currently in this phase of monitoring.

The postoperational phase of the radiological environmental monitoring program is initiated at the conclusion of the operational phase. When the plant is shut down for decommissioning, environmental samples are collected from the network of sampling sites established for preoperational and operational monitoring. Individual and cumulative measurement results are compared to baseline data to discern any trends that may be indicative of the impact of plant activities during the final phase of the plant's operations. During this final phase of environmental monitoring, the number of samples and the frequency of sample collection are often reduced as the plant decommissioning nears completion. The Big Rock Point Plant is currently in this phase of monitoring. Environmental sampling may be discontinued in 2007, following the conclusion of site decommissioning.

ATMOSPHERIC MONITORING

Sampling Network

The atmospheric monitoring network consists of two to five sampling stations in the vicinity of each of the four Michigan nuclear power plant sites and a background reference station in Lansing. At each station a highly efficient vacuum pump continuously draws ambient air, first through a particulate filter and then through a charcoal filter to collect air particulates and air vapors, respectively. Particulate filters are analyzed for gross beta activity three days after the end of sample collection, and charcoal filters are analyzed as soon as possible after the end of sample collection for the presence of radioactive iodine isotopes. Radiation atmospheric monitoring in Michigan was initiated in November 1958, with the first sampling station at the Fermi Plant site. Air monitoring stations were added to the Fermi site vicinity, as well as setting up multiple sampling stations in the vicinities of the Big Rock Point (July 1960), Palisades (November 1968), and D. C. Cook (September 1971) Plant sites. The background reference station in Lansing became operational in February 1961.

Historical and Preoperational Atmospheric Monitoring

A detailed presentation of both historical and preoperational atmospheric monitoring results, historical monitoring trends, and determination of preoperational air monitoring baselines for the four Michigan nuclear power plant areas were presented in the *MREMP Report 1958-1996*. These detailed discussions are not repeated in this report, but updated versions of two atmospheric monitoring historical plots are shown in Figures 1 and 2. Air particulate activities are reported in units of picocuries per cubic meter (pCi/m^3). The air monitoring baseline analyses are presented in Tables 1-4 for each of the four plants.

The plot of the monthly average air particulate gross beta activity for the longest running MREMP air station, at the Fermi Plant site, has been updated with the additional two years of data and is shown in Figure 1. Also, the quarterly average air particulate activity for the four nuclear plant sites along with the Lansing background reference site is updated through 2004 and is shown in Figure 2. Visual examination of the two figures reveals that the additional two years of monitoring results are essentially a continuation of the natural background trend that has prevailed since the Chernobyl accident in 1986.

Figure 1

Monthly Average Air Particulate Activity
Fermi Nuclear Power Plant

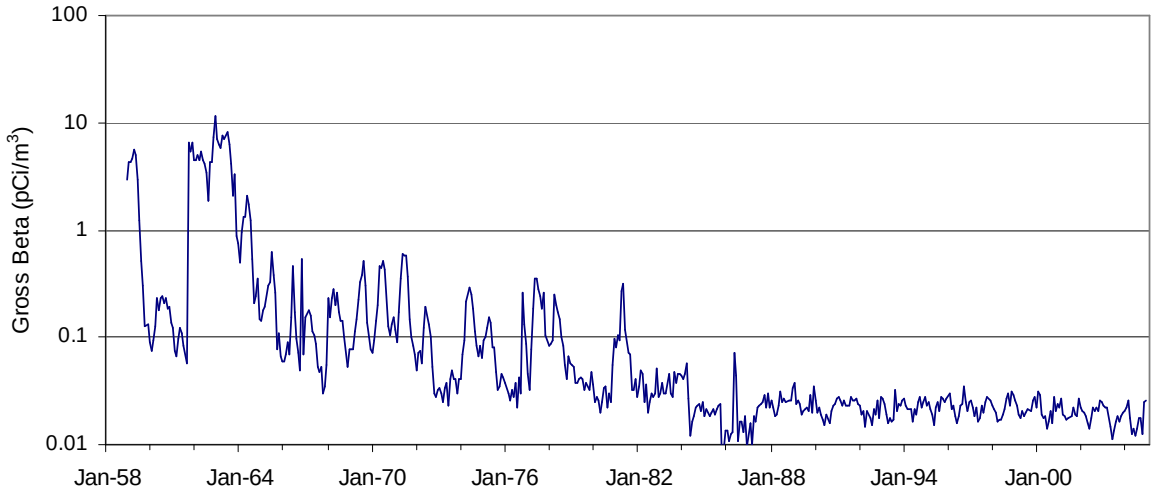


Figure 2

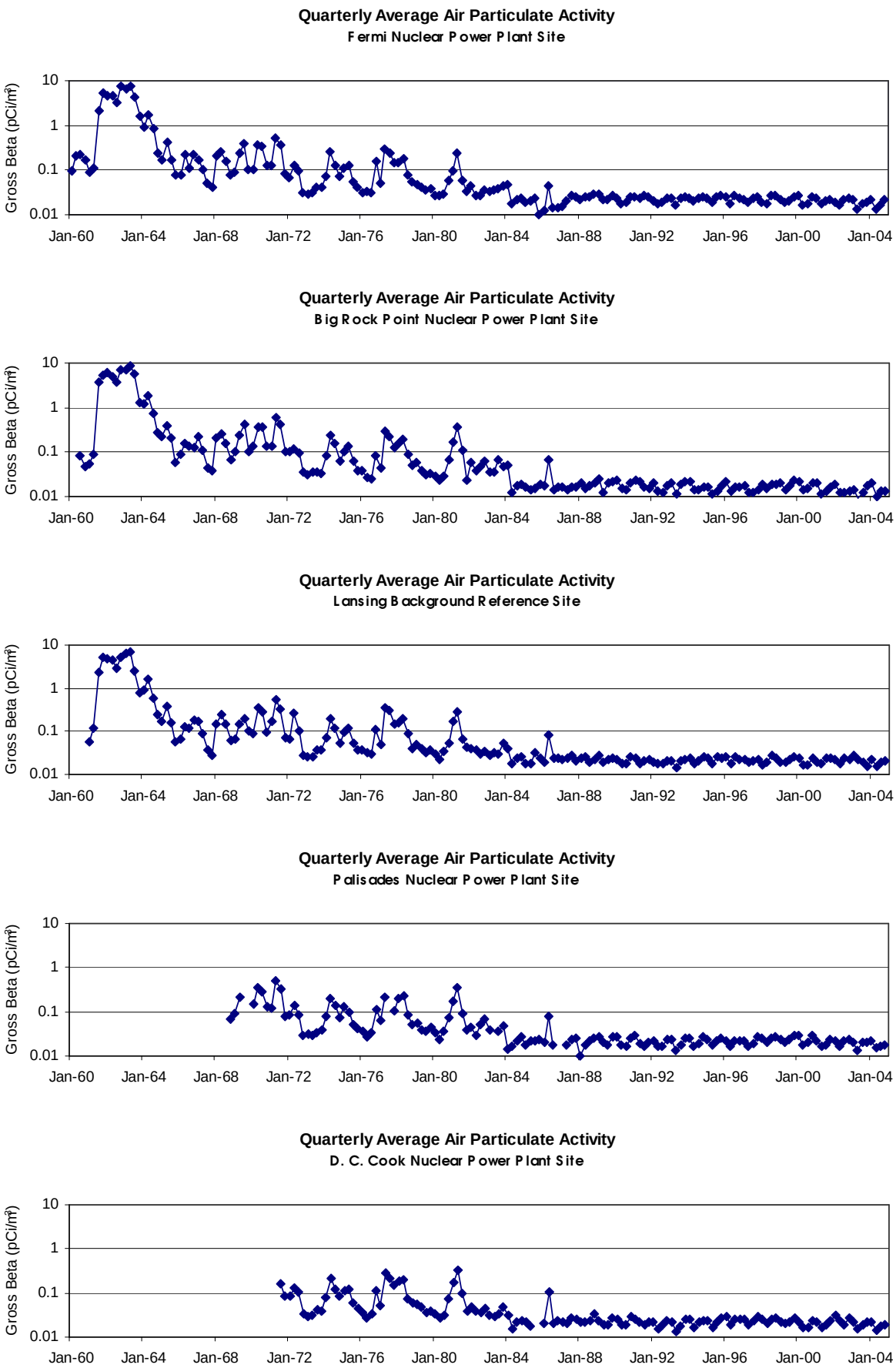

Quarterly Average Air Particulate Activity
Fermi Nuclear Power Plant Site
Gross Beta (pCi/m³)
10
1
0.1
0.01
Jan-60
Jan-64
Jan-68
Jan-72
Jan-76
Jan-80
Jan-84
Jan-88
Jan-92
Jan-96
Jan-00
Jan-04
Quarterly Average Air Particulate Activity
Big Rock Point Nuclear Power Plant Site
Gross Beta (pCi/m³)
10
1
0.1
0.01
Jan-60
Jan-64
Jan-68
Jan-72
Jan-76
Jan-80
Jan-84
Jan-88
Jan-92
Jan-96
Jan-00
Jan-04
Quarterly Average Air Particulate Activity
Lansing Background Reference Site
Gross Beta (pCi/m³)
10
1
0.1
0.01
Jan-60
Jan-64
Jan-68
Jan-72
Jan-76
Jan-80
Jan-84
Jan-88
Jan-92
Jan-96
Jan-00
Jan-04
Quarterly Average Air Particulate Activity
Palisades Nuclear Power Plant Site
Gross Beta (pCi/m³)
10
1
0.1
0.01
Jan-60
Jan-64
Jan-68
Jan-72
Jan-76
Jan-80
Jan-84
Jan-88
Jan-92
Jan-96
Jan-00
Jan-04
Quarterly Average Air Particulate Activity
D. C. Cook Nuclear Power Plant Site
Gross Beta (pCi/m³)
10
1
0.1
0.01
Jan-60
Jan-64
Jan-68
Jan-72
Jan-76
Jan-80
Jan-84
Jan-88
Jan-92
Jan-96
Jan-00
Jan-04

Table 1 **BIG ROCK POINT PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS**			
	Reactor Site	Charlevoix	Burgess
Number of Samples	58	60	60
Highest Result (pCi/m^3)	0.13	0.15	0.14
Lowest Result (pCi/m^3)	0.02	0.02	0.03
Arithmetic Mean (pCi/m^3)	0.07	0.07	0.07
Geometric Mean(pCi/m^3)	0.06	0.06	0.06

Table 2 **PALISADES PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS**			
	Reactor Site	Covert	South Haven
Number of Samples	57	55	44
Highest Result (pCi/m^3)	0.70	0.92	0.64
Lowest Result (pCi/m^3)	0.06	0.06	0.07
Arithmetic Mean (pCi/m^3)	0.24	0.25	0.25
Geometric Mean (pCi/m^3)	0.19	0.20	0.21

Table 3 **D. C. COOK PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS**					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	48	22	30	25	28
Highest Result (pCi/m^3)	0.34	0.24	0.37	0.37	0.20
Lowest Result (pCi/m^3)	0.04	0.05	0.04	0.04	0.03
Arithmetic Mean (pCi/m^3)	0.13	0.13	0.11	0.09	0.10
Geometric Mean (pCi/m^3)	0.11	0.11	0.09	0.08	0.08

Table 4 **FERMI 2 PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS**						
	Reactor Site	Rockwood	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	125	132	106	130	127	131
Highest Result (pCi/m^3)	0.09	0.09	0.08	0.11	0.07	0.07
Lowest Result (pCi/m^3)	0.01	0.01	0.01	0.01	0.01	0.01
Arithmetic Mean (pCi/m^3)	0.03	0.03	0.03	0.03	0.03	0.03
Geometric Mean (pCi/m^3)	0.03	0.02	0.03	0.03	0.03	0.03

Atmospheric Monitoring 2002-2004

The air particulate monitoring results from the four nuclear power plant areas and the Lansing background reference station were very consistent with recent years. During the 2002-2004 monitoring period, air particulate levels remained at natural background levels, with no discernible increasing or decreasing trends. There were no air vapor Iodine-131 (^{131}I) results exceeding the analytical Minimum Detectable Activity (MDA) level of 0.02 to 0.03 pCi/m^3, decay corrected to the end of sample, for samples collected during the three-year period. Details of the air particulate gross beta monitoring results for each of the four plants with comparisons to their respective preoperational baseline data and to the Lansing station are discussed below. Also, plots of gross beta results of each station for 2002-2004 are shown in Figures 3-18. The air monitoring results in tabular form are presented in Appendix A of this report.

Big Rock Point

Atmospheric monitoring for Big Rock Point for 2002-2004 consisted of the two monitoring stations; one at the reactor site and one southwest of the plant site in Charlevoix. For the three-year period, there were no distinguishable peaks or trends in the gross beta results for the two stations, with the levels oscillating between the extremes of 0.003 pCi/m^3 and 0.030 pCi/m^3. Gross beta data from the two stations were analyzed for central tendencies and measurement extremes, and the results of these analyses are presented in Table 5.

Table 5
BIG ROCK POINT AIR PARTICULATE MONITORING RESULTS 2002-2004

2002 Monitoring Results		
	Reactor Site	Charlevoix
Number of Samples	51	51
Highest Result (pCi/m^3)	0.030	0.027
Lowest Result (pCi/m^3)	0.005	0.006
Arithmetic Mean (pCi/m^3)	0.014	0.013
Geometric Mean (pCi/m^3)	0.013	0.012
2003 Monitoring Results		
	Reactor Site	Charlevoix
Number of Samples	53	53
Highest Result (pCi/m^3)	0.030	0.026
Lowest Result (pCi/m^3)	0.006	0.005
Arithmetic Mean (pCi/m^3)	0.013	0.014
Geometric Mean (pCi/m^3)	0.012	0.013
2004 Monitoring Results		
	Reactor Site	Charlevoix
Number of Samples	51	51
Highest Result (pCi/m^3)	0.028	0.025
Lowest Result (pCi/m^3)	0.005	0.003
Arithmetic Mean (pCi/m^3)	0.014	0.012
Geometric Mean (pCi/m^3)	0.013	0.012

The average air particulate gross beta concentration during the preoperational monitoring period was 0.070 pCi/m^3 for the Big Rock Point area. This preoperational average is four to five times higher than the 2002-2004 area average concentration of 0.013 pCi/m^3. The average air particulate gross beta concentration for the Lansing background reference station during 2002-2004 was 0.021 pCi/m^3, which is about 50 percent higher than the Big Rock Point area average and is consistent with results from previous years.

Palisades

Three atmospheric monitoring stations were operated in the environs of the Palisades Plant during 2002-2004 period: one at the reactor site, a second north of the plant in South Haven, and the third southeast of the plant near Covert. There were no distinguishable peaks or trends in the gross beta results for all three stations during the three-year period, with the levels oscillating between the extremes of 0.003 pCi/m^3 and 0.039 pCi/m^3. Gross beta data from the three stations were analyzed for central tendencies and measurement extremes and are presented in Table 6.

Table 6
PALISADES AIR PARTICULATE MONITORING RESULTS 2002-2004

2002 Monitoring Results			
	Reactor Site	Covert	South Haven
Number of Samples	52	53	52
Highest Result (pCi/m^3)	0.039	0.036	0.037
Lowest Result (pCi/m^3)	0.010	0.011	0.006
Arithmetic Mean (pCi/m^3)	0.021	0.020	0.020
Geometric Mean (pCi/m^3)	0.020	0.019	0.019
2003 Monitoring Results			
	Reactor Site	Covert	South Haven
Number of Samples	50	51	51
Highest Result (pCi/m^3)	0.033	0.026	0.033
Lowest Result (pCi/m^3)	0.009	0.006	0.008
Arithmetic Mean (pCi/m^3)	0.019	0.015	0.018
Geometric Mean (pCi/m^3)	0.018	0.014	0.017
2004 Monitoring Results			
	Reactor Site	Covert	South Haven
Number of Samples	52	52	50
Highest Result (pCi/m^3)	0.035	0.030	0.031
Lowest Result (pCi/m^3)	0.010	0.007	0.003
Arithmetic Mean (pCi/m^3)	0.018	0.014	0.017
Geometric Mean (pCi/m^3)	0.017	0.013	0.016

The average air particulate gross beta concentration during the preoperational monitoring period was 0.25 pCi/m^3 for the Palisades Plant area. This preoperational average was about twelve times higher than the area average concentration of 0.018 pCi/m^3, for 2002-2004 period. The average air particulate gross beta concentration for the Lansing background reference station was 0.021 pCi/m^3 during the 2002-2004 period, which is very similar to the average level of the three Palisades stations.

D. C. Cook

Five atmospheric monitoring stations were operated in the environs of the D. C. Cook Plant during 2002-2004. One is located at the reactor site, a second is south of the plant in Bridgman, a third is northeast of the plant in Stevensville, a fourth is at the west end of Livingston Road near the south boundary of the plant site, and a fifth is about three miles due east of the plant. There were no distinguishable peaks or trends in the gross beta results for all five stations during the 2002-2004 period, with the levels oscillating between the extremes of 0.005 pCi/m^3 and 0.060 pCi/m^3. Gross beta data from the five stations were analyzed for central tendencies and measurement extremes. The results of these analyses are presented in Table 7.

Table 7
D. C. COOK AIR PARTICULATE MONITORING RESULTS 2002-2004

2002 Monitoring Results					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	50	53	52	53	52
Highest Result (pCi/m^3)	0.049	0.047	0.041	0.038	0.060
Lowest Result (pCi/m^3)	0.012	0.011	0.007	0.013	0.013
Arithmetic Mean (pCi/m^3)	0.025	0.024	0.019	0.023	0.025
Geometric Mean (pCi/m^3)	0.024	0.023	0.017	0.022	0.023
2003 Monitoring Results					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	52	52	51	51	51
Highest Result (pCi/m^3)	0.033	0.035	0.035	0.031	0.034
Lowest Result (pCi/m^3)	0.008	0.008	0.009	0.008	0.008
Arithmetic Mean (pCi/m^3)	0.019	0.021	0.021	0.020	0.021
Geometric Mean (pCi/m^3)	0.019	0.020	0.020	0.019	0.020
2004 Monitoring Results					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	52	50	52	51	52
Highest Result (pCi/m^3)	0.033	0.036	0.036	0.036	0.033
Lowest Result (pCi/m^3)	0.008	0.009	0.005	0.006	0.008
Arithmetic Mean (pCi/m^3)	0.018	0.019	0.019	0.018	0.019
Geometric Mean (pCi/m^3)	0.017	0.018	0.018	0.017	0.018

The average air particulate gross beta concentration during the preoperational monitoring period was 0.11 pCi/m^3 for the D. C. Cook Plant area. This preoperational gross beta concentration is almost six times higher than the average concentration of 0.021 pCi/m^3, for the 2002-2004 monitoring period. The average air particulate gross beta concentration for the Lansing background reference station was 0.021 pCi/m^3 during the 2002-2004 period, which is the same as the area average levels at the five D. C. Cook stations.

Fermi 2

Five atmospheric monitoring stations were operated in the environs of the Fermi 2 Plant during 2002-2004. One is located at the reactor site, a second south of the plant on Pointe Aux Peaux Road, a third southwest of the plant on Nadeau Road, a forth on Dixie Highway due west of the plant, and the fifth station at the Fix Farm, northwest of the plant on Post Road. There were no distinguishable peaks or trends in the gross beta results for all six stations during the 2002-2004 period, with the levels oscillating between the extremes of 0.003 pCi/m^3 and 0.064 pCi/m^3. Gross beta data from the five stations were analyzed for central tendencies and measurement extremes. The results of these analyses are presented in Table 8.

Table 8
FERMI 2 AIR PARTICULATE MONITORING RESULTS 2002-2004

2002 Monitoring Results					
	Reactor Site	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	51	51	52	51	52
Highest Result (pCi/m^3)	0.037	0.059	0.036	0.041	0.051
Lowest Result (pCi/m^3)	0.010	0.012	0.010	0.012	0.009
Arithmetic Mean (pCi/m^3)	0.020	0.032	0.018	0.021	0.020
Geometric Mean (pCi/m^3)	0.019	0.030	0.017	0.020	0.019
2003 Monitoring Results					
	Reactor Site	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	52	51	51	51	52
Highest Result (pCi/m^3)	0.031	0.046	0.030	0.034	0.035
Lowest Result (pCi/m^3)	0.007	0.007	0.003	0.006	0.008
Arithmetic Mean (pCi/m^3)	0.018	0.020	0.015	0.017	0.020
Geometric Mean (pCi/m^3)	0.017	0.019	0.014	0.016	0.019
2004 Monitoring Results					
	Reactor Site	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	52	53	53	53	53
Highest Result (pCi/m^3)	0.034	0.064	0.033	0.033	0.035
Lowest Result (pCi/m^3)	0.004	0.006	0.005	0.010	0.010
Arithmetic Mean (pCi/m^3)	0.018	0.020	0.017	0.018	0.020
Geometric Mean (pCi/m^3)	0.017	0.019	0.016	0.017	0.019

The area average air particulate gross beta concentration during the preoperational monitoring period was 0.03 pCi/m^3 for Fermi 2. This preoperational gross beta concentration is just slightly higher than the area average concentrations of 0.020 pCi/m^3 measured during the 2002-2004 period. The average air particulate gross beta concentration for the Lansing background reference station was 0.021 pCi/m^3 during the 2002-2004 period, which is almost the same as the area average level measured in the Fermi 2 area.

Figure 3

Air Particulate Monitoring

Big Rock Point Reactor Site 2002-2004

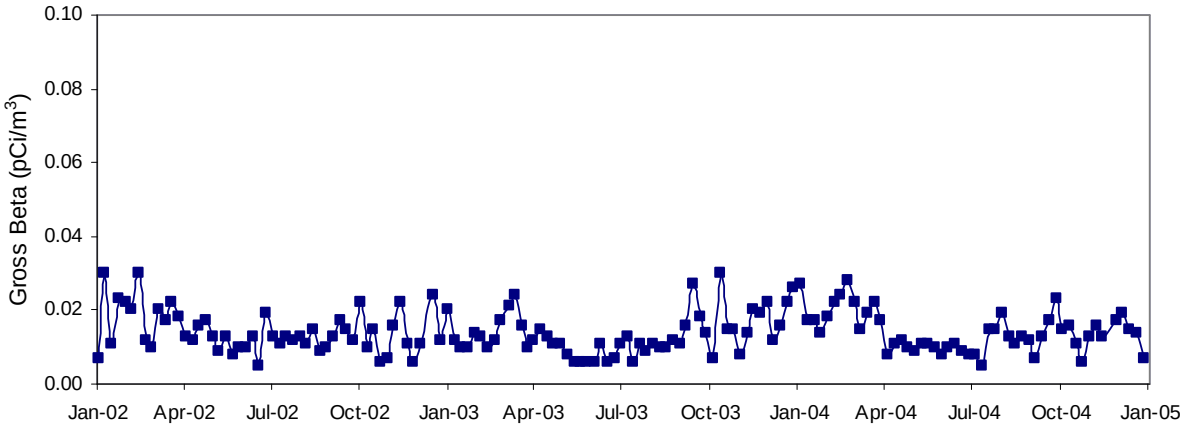


Figure 4

Air Particulate Monitoring

Big Rock Point Charlevoix Site 2002-2004

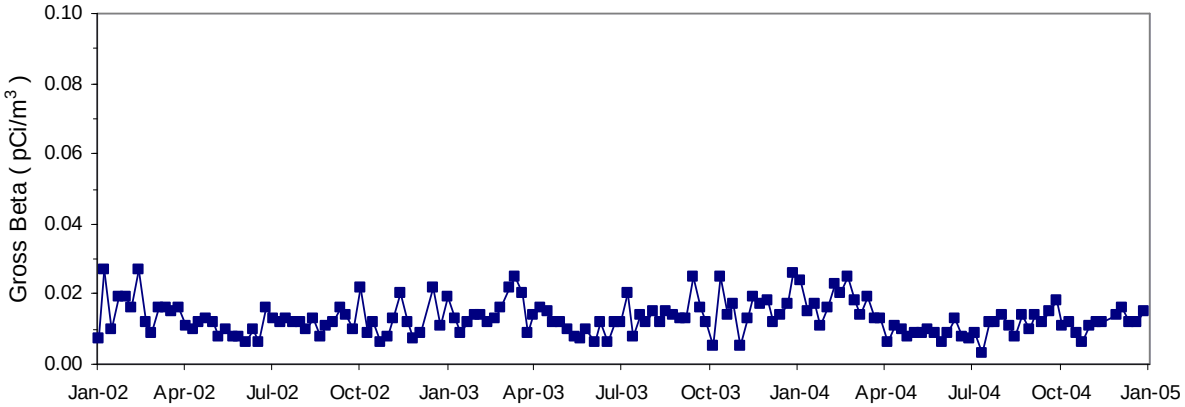


Figure 5

Air Particulate Monitoring

Palisades Reactor Site 2002-2004

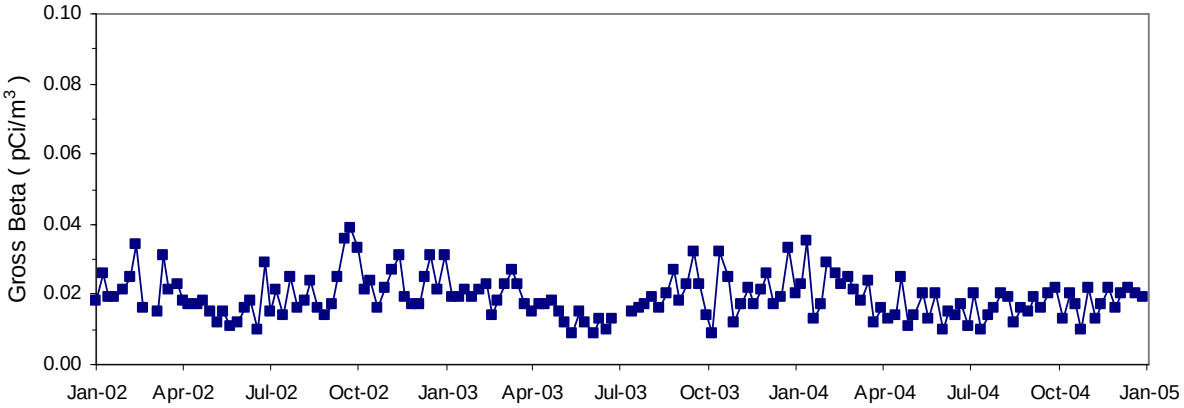


Figure 6

Air Particulate Monitoring

Palisades Covert Site 2002-2004

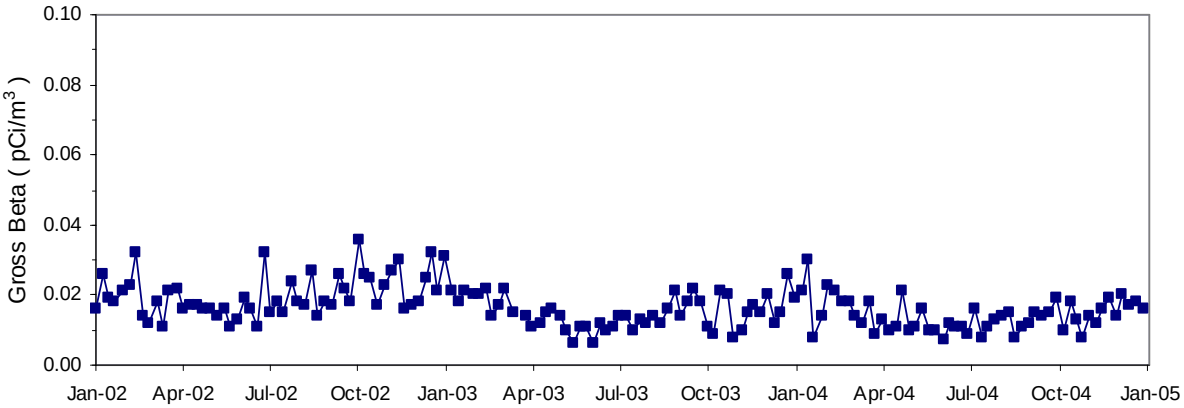


Figure 7

Air Particulate Monitoring

Palisades South Haven Site 2002-2004

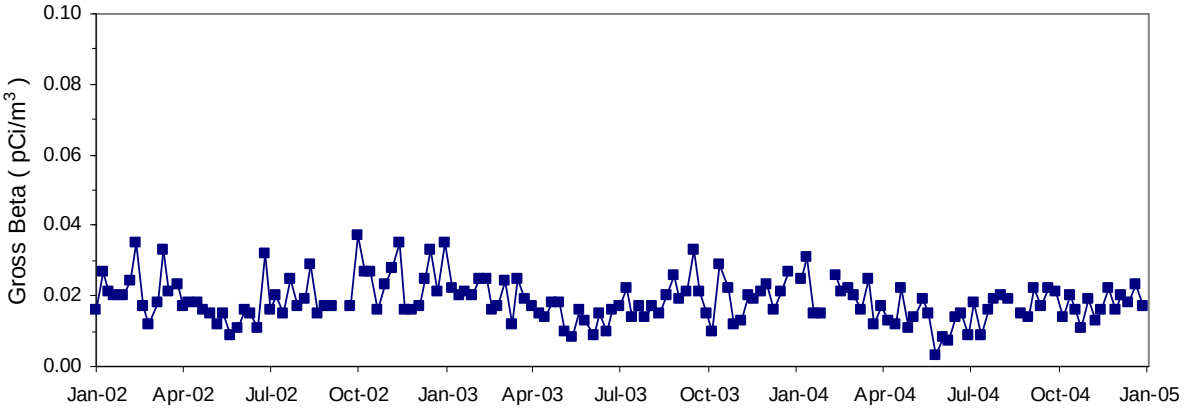


Figure 8

Air Particulate Monitoring

D. C. Cook Reactor Site 2002-2004

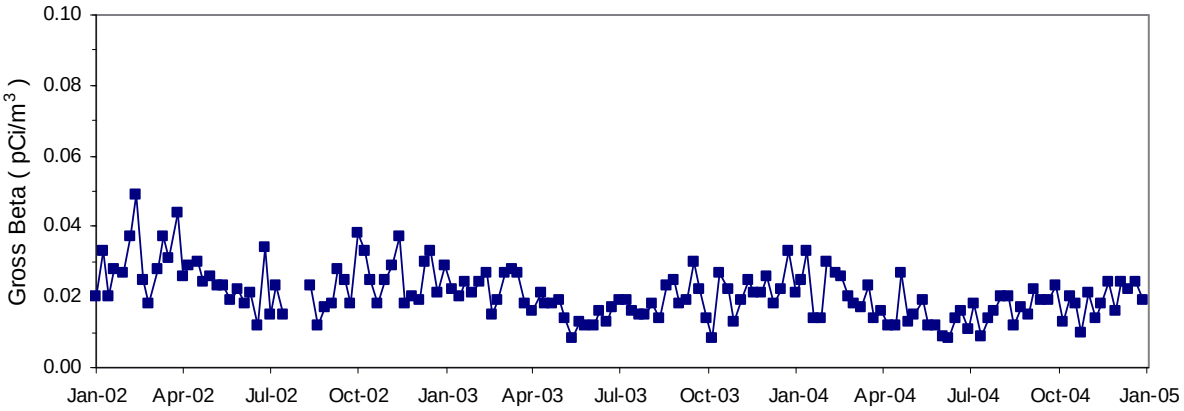


Figure 9

Air Particulate Monitoring

D. C. Cook Bridgman Site 2002-2004

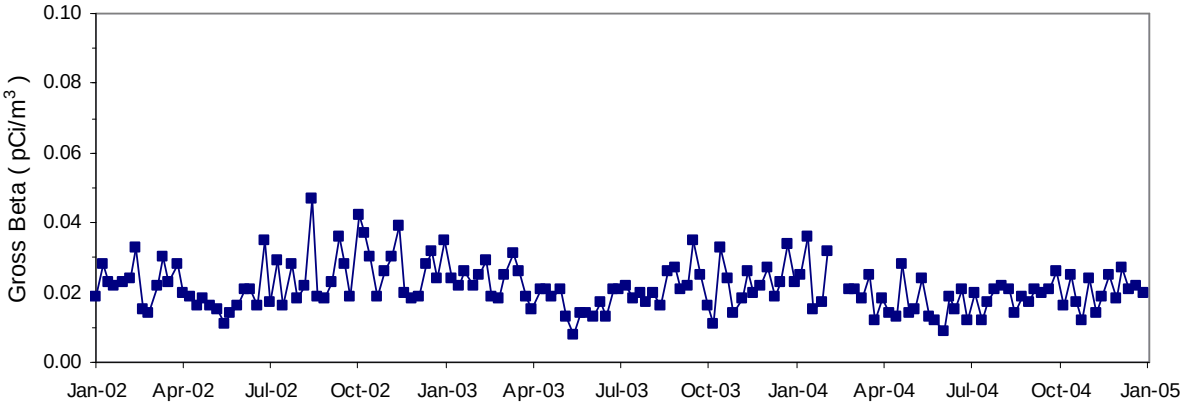


Figure 10

Air Particulate Monitoring

D. C. Cook Stevensville Site 2002-2004

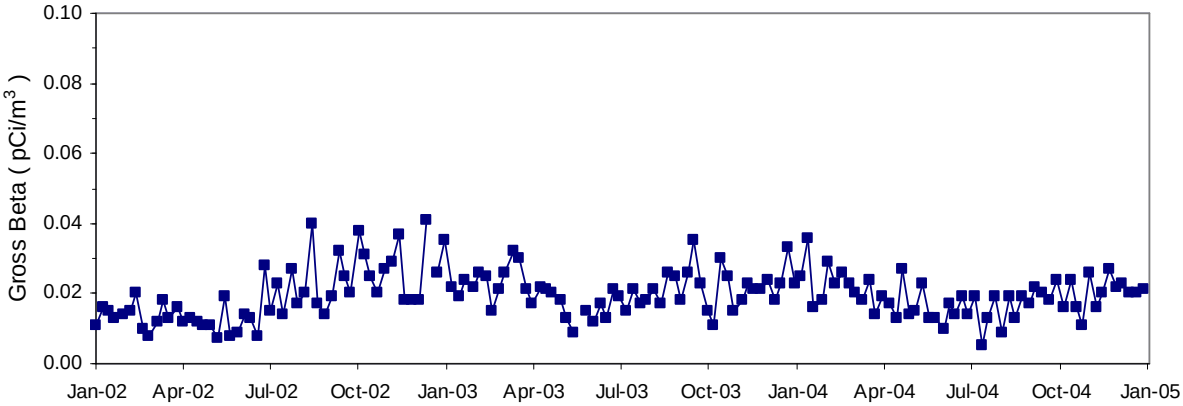


Figure 11

Air Particulate Monitoring

D. C. Cook Livingston Road Site 2002-2004

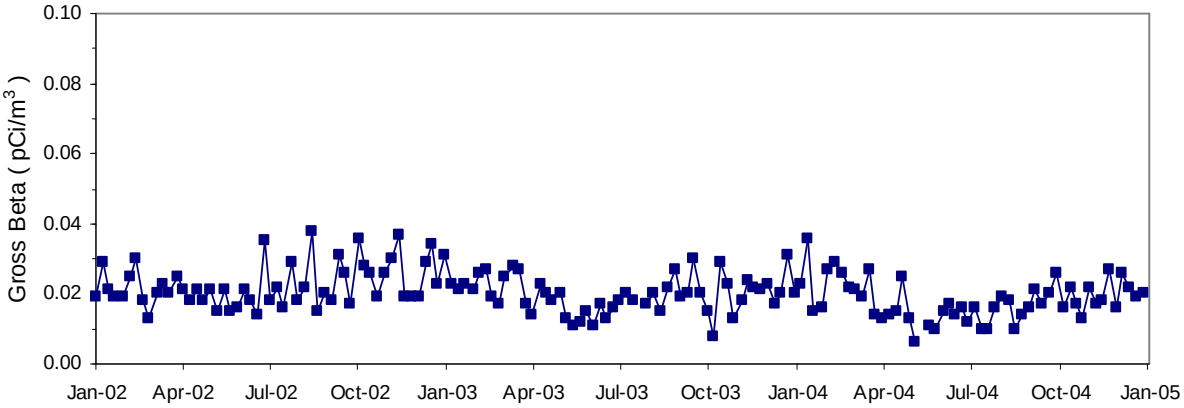


Figure 12

Air Particulate Monitoring

D. C. Cook Peddy Farm Site 2002-2004

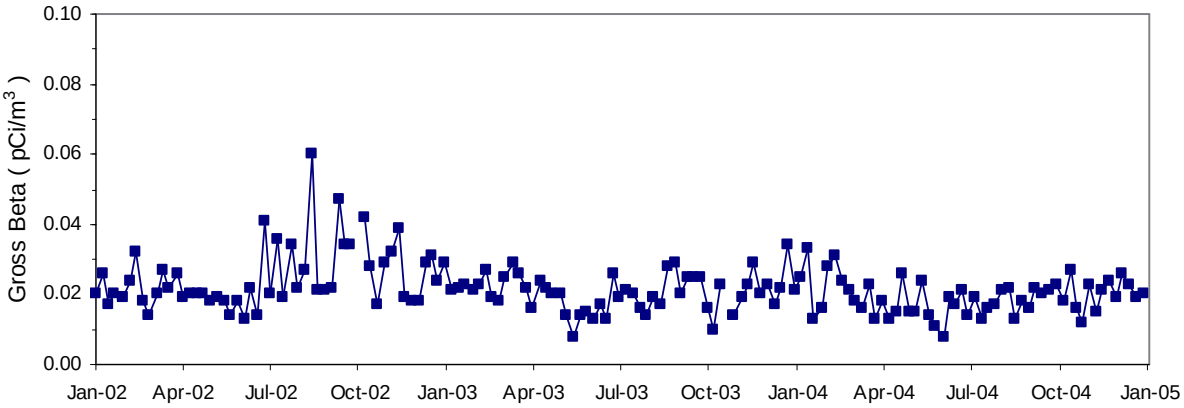


Figure 13

Air Particulate Monitoring

Fermi 2 Reactor Site 2002-2004

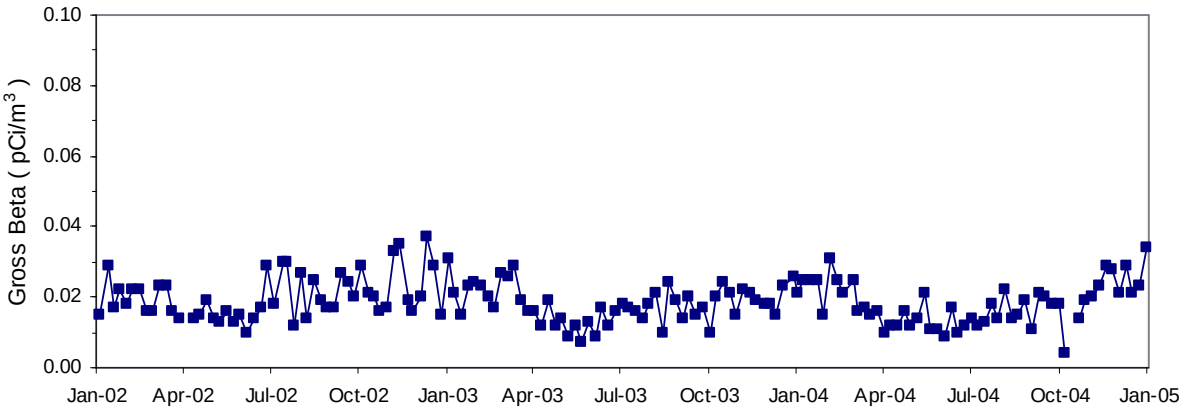


Figure 14

Air Particulate Monitoring

Fermi 2 Pointe Aux Peaux Road Site 2002-2004

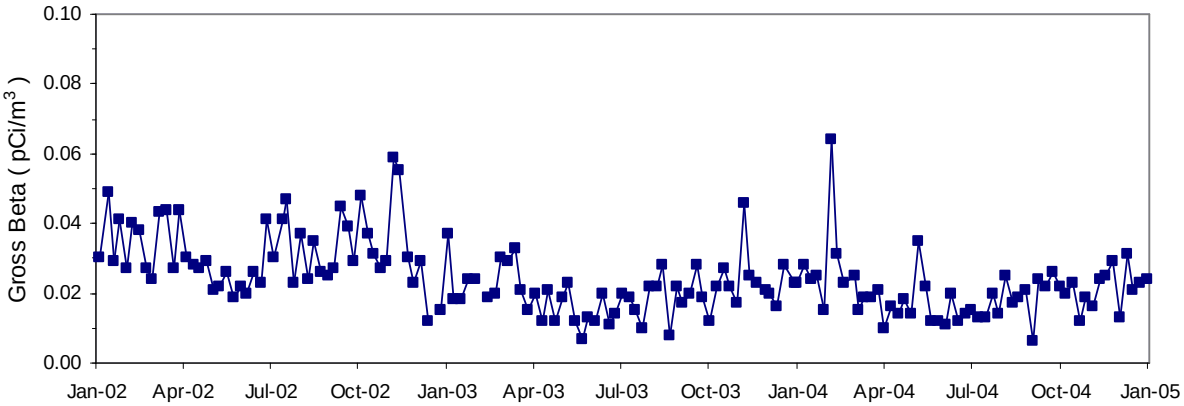


Figure 15

Air Particulate Monitoring

Fermi 2 Nadeau Road Site 2002-2004

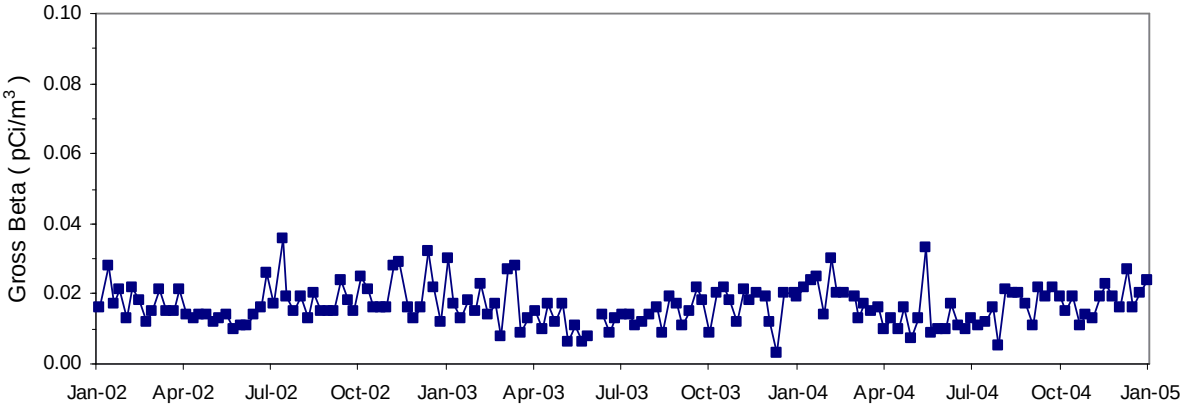


Figure 16

Air Particulate Monitoring

Fermi 2 Dixie Highway Site 2002-2004

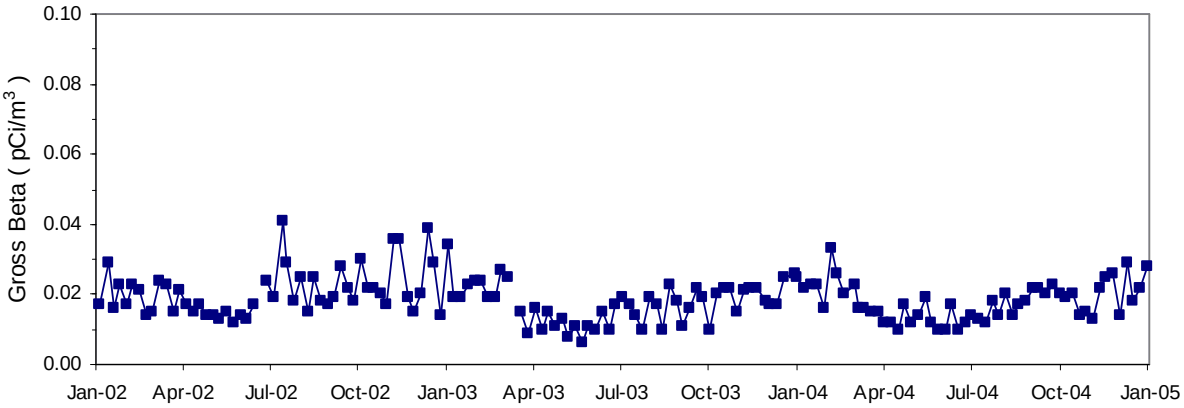


Figure 17

Air Particulate Monitoring

Fermi 2 Fix Farm Site 2002-2004

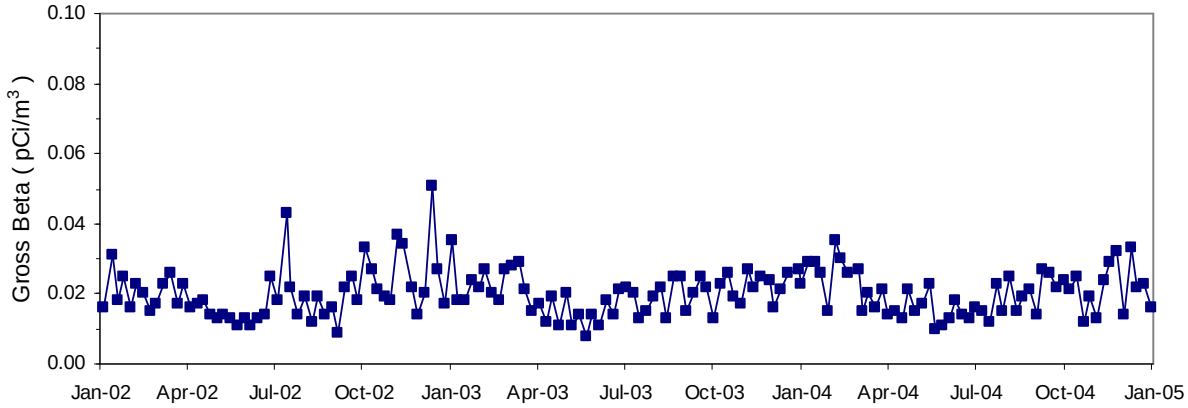
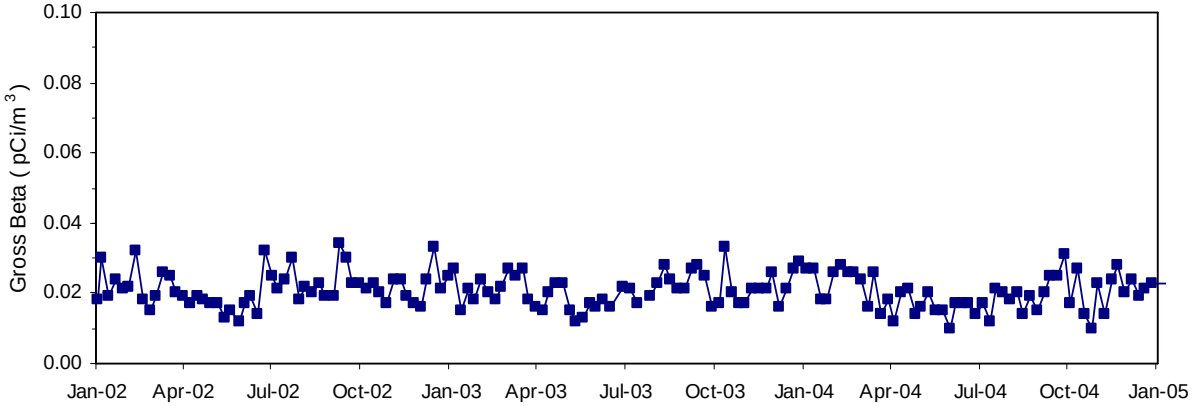


Figure 18

Air Particulate Monitoring

Lansing Background Reference Site 2002-2004



TERRESTRIAL MONITORING

Sampling Network

The terrestrial monitoring network consists of seven milk sampling stations: three of which are located near the state's nuclear power plants, and the other four scattered around the state for geographical and population coverage. Sampling at the Charlevoix, Detroit, Grand Rapids, Lansing, Marquette, and Monroe milk stations was initiated in late 1962 and the South Haven milk station was added in 1969. Weekly samples are collected for the South Haven station; biweekly samples are collected for the Charlevoix, Lansing, Marquette, and Monroe stations; and monthly samples are collected for the Detroit and Grand Rapids stations. Pasteurized milk samples from a local dairy were collected for all seven stations until the late 1970s. During the late 1970s and the early 1980s, all local dairies in the Charlevoix, Monroe, and South Haven areas closed and sampling for these three stations were shifted to raw milk samples from a local dairy farm. Pasteurized milk samples, collected from a local dairy, for the Detroit, Grand Rapids, Lansing, and Marquette stations have continued through 2004. All samples are analyzed for gamma emitting radionuclides, with Iodine-131 (^{131}I) and cesium-137 (^{137}Cs) of particular interest. Radionuclide activity results for milk are reported in units of picocuries per liter (pCi/l).

Historical Terrestrial Monitoring Trends

Historical and preoperational milk monitoring results, historical monitoring trends, and the determination of preoperational milk monitoring baselines for the four plant areas was presented in detail in *MREMP Report 1958-1996*. These discussions are not repeated in this report, but the final results of the preoperational baseline analysis are presented in Tables 9-12 for comparison with the 2002-2004 milk monitoring results. Note that the Minimum Detectable Activity (MDA) has decreased dramatically since the program's inception.

Table 9
BIG ROCK POINT PREOPERATIONAL MILK MONITORING RESULTS

1963 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)
Charlevoix Average	Less than 20	136
Charlevoix Highest	Less than 20	232
Charlevoix Lowest	Less than 20	70
Statewide Average without Charlevoix	Less than 20	119
1964 Milk Monitoring Results		
Charlevoix Average	Less than 20	137
Charlevoix Highest	Less than 20	182
Charlevoix Lowest	Less than 20	71
Statewide Average without Charlevoix	Less than 20	116

Table 10 **PALISADES PREOPERATIONAL MILK MONITORING RESULTS**		
1969 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)
South Haven Average	Less than 14	11
South Haven Highest	Less than 14	16
South Haven Lowest	Less than 14	6
Statewide Average without South Haven	Less than 14	15
1970 Milk Monitoring Results		
South Haven Average	Less than 14	11
South Haven Highest	Less than 14	41
South Haven Lowest	Less than 14	Less than 6
Statewide Average without South Haven	Less than 14	14

Table 11 **D. C. COOK PREOPERATIONAL MILK MONITORING RESULTS**		
1973 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)
South Haven Average	Less than 14	6
South Haven Highest	Less than 14	20
South Haven Lowest	Less than 14	Less than 6
Statewide Average without South Haven	Less than 14	7
1974 Milk Monitoring Results		
South Haven Average	Less than 14	8
South Haven Highest	Less than 14	17
South Haven Lowest	Less than 14	Less than 6
Statewide Average without South Haven	Less than 14	9

Table 12 **FERMI 2 PREOPERATIONAL MILK MONITORING RESULTS**		
1983 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)
Monroe Average	Less than 6	Less than 5
Monroe Highest	Less than 6	13
Monroe Lowest	Less than 6	Less than 5
Statewide Average without Monroe	Less than 6	Less than 5
1984 Milk Monitoring Results		
Monroe Average	Less than 6	Less than 5
Monroe Highest	Less than 6	6
Monroe Lowest	Less than 6	Less than 5
Statewide Average without Monroe	Less than 6	Less than 5

Terrestrial Monitoring 2002-2004

Almost all of the milk monitoring results for the 405 samples analyzed during the two-year period were less than the MDA levels. The number of samples analyzed and the average analytical MDA levels for each monitoring station are delineated in Table 13. There were no samples with ^{131}I exceeding the MDA levels during the two-year period. Seven of the 405 milk samples had detectable levels of ^{137}Cs, with an average measured level of 3.3 pCi/l, which is almost identical to the average analytical MDA level for ^{137}Cs. None of the 405 samples had detectable levels of ^{90}Sr. With only 1.7 percent of the samples analyzed indicating detectable amounts of either ^{137}Cs or ^{90}Sr at levels almost equal to the analytical MDA, milk produced in Michigan is now almost virtually free of these long-lived radionuclides from past atmospheric fallout.

There were no discernible trends for the 2002-2004 milk results, with only two of the seven stations indicating at least one sample with detectable amounts of ^{137}Cs. The three samples with detectable levels of ^{137}Cs represent 0.57 percent of samples analyzed during 2002-2004, which is slightly lower than during recent years. Overall, the milk monitoring results from all sampling stations were lower than levels recorded during preoperational monitoring periods or, in the case of Big Rock Point, during the early years of plant operation. A tabular presentation of MREMP milk monitoring results for 2002-2004 is located in Appendix B. Appendix B also shows the monitoring results for potassium-40 (^{40}K), which is a naturally –occurring radionuclide that is always present in milk.

Table 13
MILK MONITORING RESULT AVERAGES 2002-2004

	Number of Samples	^{131}I (pCi/l)	^{137}Cs (pCi/l)
Charlevoix	179	Less than 4	Less than 3
Detroit	36	Less than 3	Less than 3
Grand Rapids	30	Less than 3	Less than 3
Lansing	78	Less than 2	Less than 2
Marquette	70	Less than 3	Less than 3
Monroe	79	Less than 4	Less than 2
South Haven	157	Less than 3	Less than 3
Statewide	529	Less than 3	Less than 2

AQUATIC MONITORING

Sampling Network

The aquatic monitoring network consists of nine surface water sampling stations for the four Michigan nuclear plant sites. Through 2003, a Big Rock Point Plant monthly grab sample was collected from the plant discharge canal and starting in 2004, the monthly grab sampling site was moved to the shoreline in front of the plant due to removal of the discharge canal. A monthly grab sample is collected from the Palisades plant discharge line when the plant is operational. At the D. C. Cook plant, monthly grab samples are collected from pre-discharge holding tanks for each reactor, when the reactors are operational. A monthly surface water grab sample is collected from Lake Erie in front of the Fermi plant, and four daily composite surface/drinking water sampling stations of the Detroit Edison Company are split with the MREMP on a monthly basis. All samples are analyzed for gamma emitting radionuclides, gross beta, and tritium activity.

Historical and Preoperational Aquatic Monitoring

A detailed presentation of both historical and preoperational aquatic monitoring results, historical monitoring trends, and determination of preoperational surface water monitoring baselines for the four Michigan nuclear power plant areas was presented in *MREMP Report 1958-1996*. These detailed discussions are not repeated in this report, but updated versions of four surface water historical plots are shown in Figures 19-22 and the final results of the surface water baseline analysis is presented in Tables 14-17. Visual examination of the historical surface water plots for all four plant sites reveals a continuation of the trend that has prevailed over the last decade.

Figure 19

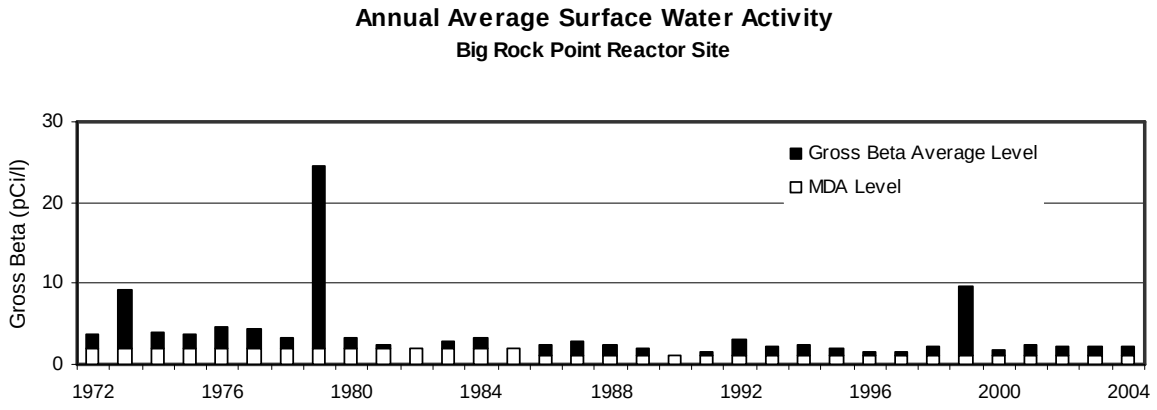


Figure 20

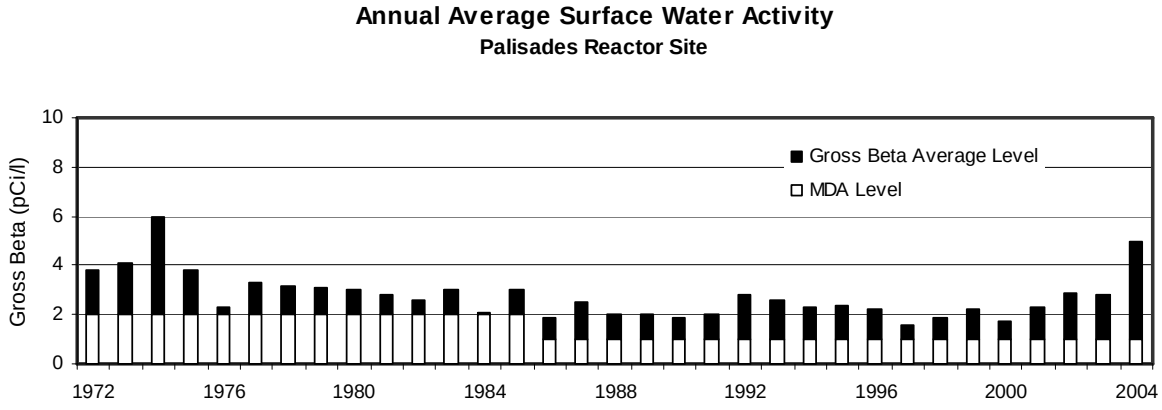


Figure 21

Annual Average Surface Water Activity
D. C. Cook Reactor Site

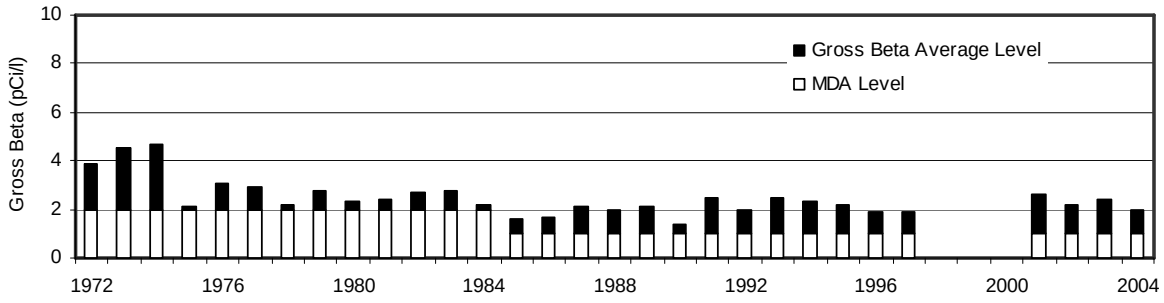


Figure 22

Annual Average Surface Water Avtivity
Fermi 2 Reactor Site

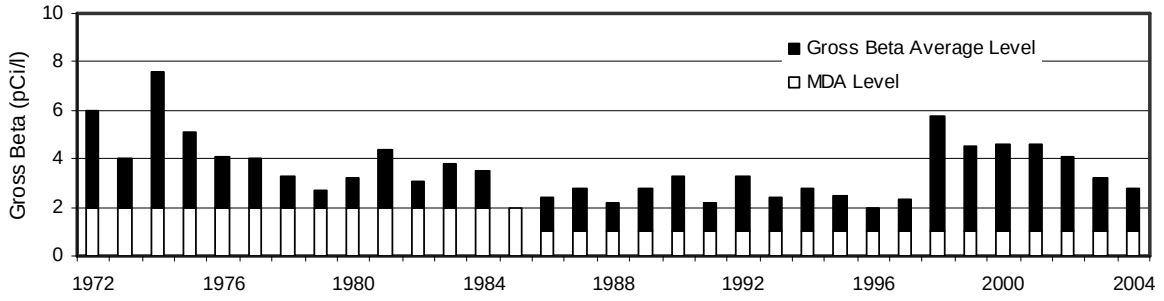


Table 14 **1972-73 BIG ROCK POINT SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	7.1	1100
Reactor Site (without 12/73 sample)	3.8	400
Non-Reactor Sites	3.9	500
Non-Reactor Sites (without 12/73 sample)	3.5	300

Table 15 **1972-73 PALISADES SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	4.0	300
Non-Reactor Sites	5.1	200

Table 16 **1973-74 D. C. COOK SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	4.2	300
Non-Reactor Sites	4.4	300

Table 17 **1983-84 FERMI 2 SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	3.6	200

Aquatic Monitoring 2002-2004

Surface water results during 2002-2004 were generally in alignment with results from recent years with a couple of exceptions. An August 2002 grab sample collected at the Fermi 2 site had a gross beta level of 16 pCi/l, and a November 2004 grab sample at the Palisades site had a level of 29 pCi/l. Even though the gross beta levels for these two samples were considerably higher than all the other surface water samples analyzed during 2002-2004, they were still within allowable limits.[1] Measured gross beta levels for all the other 2002-2004 surface water samples ranged between below the MDA level of 1 pCi/l and 8 pCi/l. Tritium levels over the three years ranged from below the MDA level of 100 pCi/l and 400 pCi/l for all of the surface water monitoring sites, except for two March 2003 and two March 2004 grab samples from the D. C. Cook Plant. The March 2003 samples had tritium levels of 2000 pCi/l and 2600 pCi/l and the March 2004 samples had tritium levels of 11,800 pCi/l and 12,200 pCi/l. All of these elevated levels are within allowable limits but definitely much higher than the other surface water tritium levels. Details of the 2002-2004 surface water monitoring results for the four plants and comparisons to their respective preoperational baseline data are discussed below. Figures 23-40 at the end of this section, show gross beta and tritium results for the nine sampling stations for 2002-2004 and a tabular presentation of the results is provided in Appendix C.

[1] NRC's tritium limit on water effluent is $1x10^6$ pCi/l. U.S. EPA's Drinking Water MCL is 20,000 pCi/l.

Big Rock Point

Aquatic monitoring for Big Rock Point during 2002-2004 consisted of the one sampling station at the reactor site. Monthly grab samples of surface water are collected and analyzed in the same manner as they were during the baseline assessment period. The results for the three-year period are summarized in Table 18

The gross beta arithmetic mean of 2.1 pCi/l for the 2002-2004 period was much lower than the 3.8 pCi/l average measured during the 1972-73 baseline assessment period. The less than 100 pCi/l tritium average for the two-year period, is also much less than the 400 pCi/l average tritium level measured during 1972-1973. None of the 25 samples showed any significant gamma activity above MDA levels.

Table 18
BIG ROCK POINT SURFACE WATER RESULTS 2002-2004

	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site		
Number of Samples	25	25
Highest Result	4	Less than 100
Lowest Result	Less than 1	Less than 100
Arithmetic Mean	2.1	Less than 100
Geometric Mean	2.0	Less than 100

Palisades

Palisades Plant aquatic monitoring during 2002-2004 consisted of one surface water sampling station at the reactor site. Monthly grab samples were collected from the reactor discharge and analyzed in the same manner as they were during the baseline assessment period. The results for the three-year period are summarized in Table 19. The Palisades reactor site surface water result gross beta average of 3.5 pCi/l for the three-year period is less than the baseline assessment period average of 4.0 pCi/l. When the one high result of 29 pCi/l is excluded from the average calculation a result of 2.6 pCi/l is obtained, which is comparable to the average levels measured in recent years. The tritium average of less than 100 pCi/l is considerably less that the 300 pCi/l average measured during the baseline assessment years. None of the 31 samples showed any significant gamma activity above MDA levels.

Table 19
PALISADES SURFACE WATER RESULTS 2002-2004

	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site		
Number of Samples	31	31
Highest Result	29	400
Lowest Result	2	Less Than 100
Arithmetic Mean	3.5	Less Than 100
Geometric Mean	2.8	Less Than 100

D. C. Cook

Aquatic monitoring for D. C. Cook during 2002-2004 consisted of two surface water sampling stations at the reactor site, one for each reactor unit. Monthly grab samples were collected from the reactor discharge holding tank for each unit and analyzed in the same manner as they were during the baseline assessment period. The results for the three-year period are summarized in Table 20. Surface water gross beta averages for both reactor units during the three-year period were less than the preoperational baseline assessment period average of 4.2 pCi/l. Tritium averages for both units were greater than the baseline average of 300 pCi/l during 2002-2004, but these averages were strongly influenced by the previously sited elevated results in March 2003 and March 2004. Excluding these elevated results, the three-year tritium averages for both reactor units are less than 100 pCi/l. None of the 68 total surface water samples collected at the D. C. Cook Plant during 2002-2004 indicated any significant gamma activity above minimum detectable levels.

Table 20
D. C. COOK SURFACE WATER RESULTS 2002-2004

	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site – Unit 1		
Number of Samples	34	34
Highest Result	6	12200
Lowest Result	Less Than 1	Less Than 100
Arithmetic Mean	2.2	480
Geometric Mean	1.9	Less Than 100
Reactor Site – Unit 2		
Number of Samples	34	34
Highest Result	4	11800
Lowest Result	Less Than 1	Less Than 100
Arithmetic Mean	2.2	450
Geometric Mean	2.0	Less Than 100

Fermi 2

Fermi 2 aquatic monitoring during 2002-2004 consisted of monthly samples from five surface water sampling sites. These consisted of a monthly grab sample collected from Lake Erie directly in front of the reactor site by MREMP staff and four daily composited samples collected monthly by Fermi 2 Plant staff. All monthly samples are analyzed in the same manner as they were during the baseline assessment period, and the results for the 2002-2004 period are summarized in Table 21.

During the 2002-2004 monitoring period, surface water gross beta averages for the Fermi 2 Plant area were all lower than the preoperational baseline assessment period average of 3.6 pCi/l. Tritium averages during the 2002-2004 monitoring period were slightly lower than the baseline assessment period for all five monitoring sites.

Table 21
FERMI 2 SURFACE WATER RESULTS 2002-2004

	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site		
Number of Samples	32	32
Highest Result	16	100
Lowest Result	Less Than 1	Less Than 100
Arithmetic Mean	3.4	Less Than 100
Geometric Mean	2.8	Less Than 100
Monroe Intake Site		
Number of Samples	36	36
Highest Result	5	Less Than 100
Lowest Result	LT 1	Less Than 100
Arithmetic Mean	2.4	Less Than 100
Geometric Mean	2.2	Less Than 100
Trenton Channel Site		
Number of Samples	35	35
Highest Result	4	100
Lowest Result	1	Less Than 100
Arithmetic Mean	2.2	Less Than 100
Geometric Mean	2.1	Less Than 100
Allen Park Intake Site		
Number of Samples	36	36
Highest Result	5	200
Lowest Result	LT 1	Less Than 100
Arithmetic Mean	2.3	Less Than 100
Geometric Mean	2.0	Less Than 100
Fermi 2 Intake Site		
Number of Samples	36	36
Highest Result	4	200
Lowest Result	LT 1	Less Than 100
Arithmetic Mean	2.2	Less Than 100
Geometric Mean	2.1	Less Than 100

Figure 23

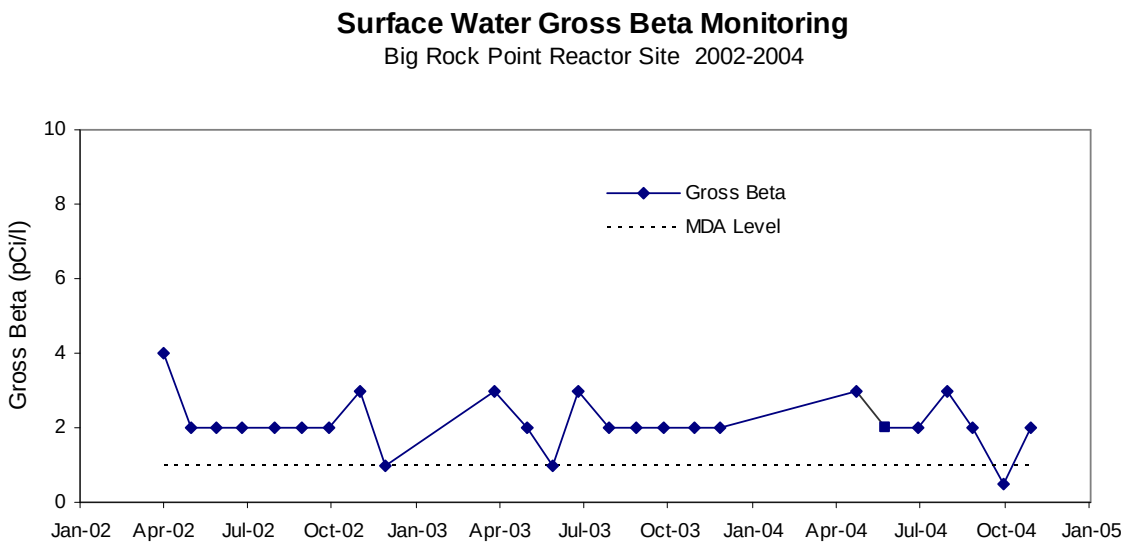
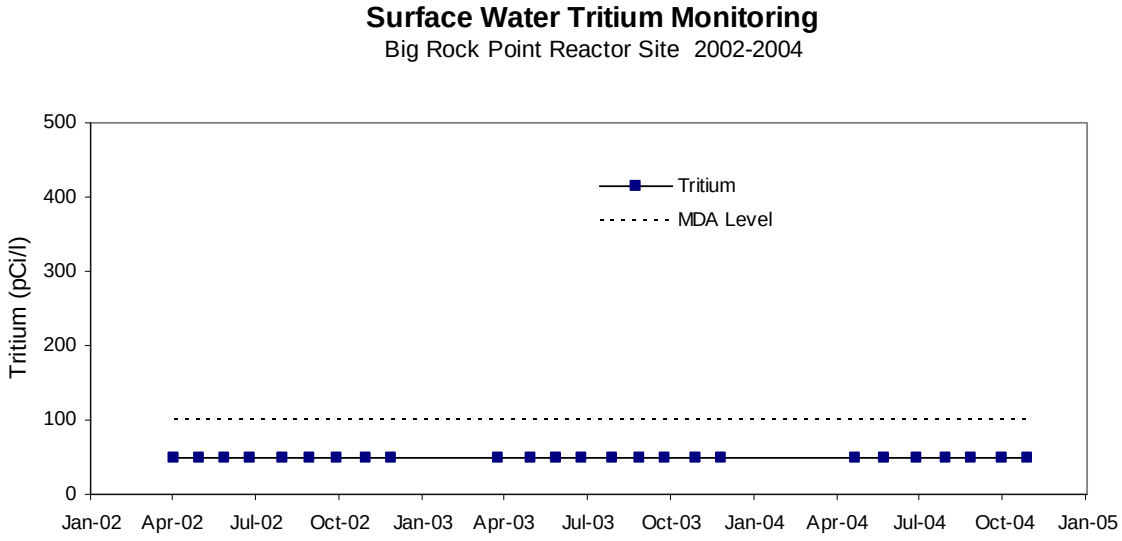


Figure 24



Note: Some graphs show the sample value to be below the MDA. The depiction of results below the MDA do not depict a discreet value, but simply that the result was below the level of detection.

Figure 25

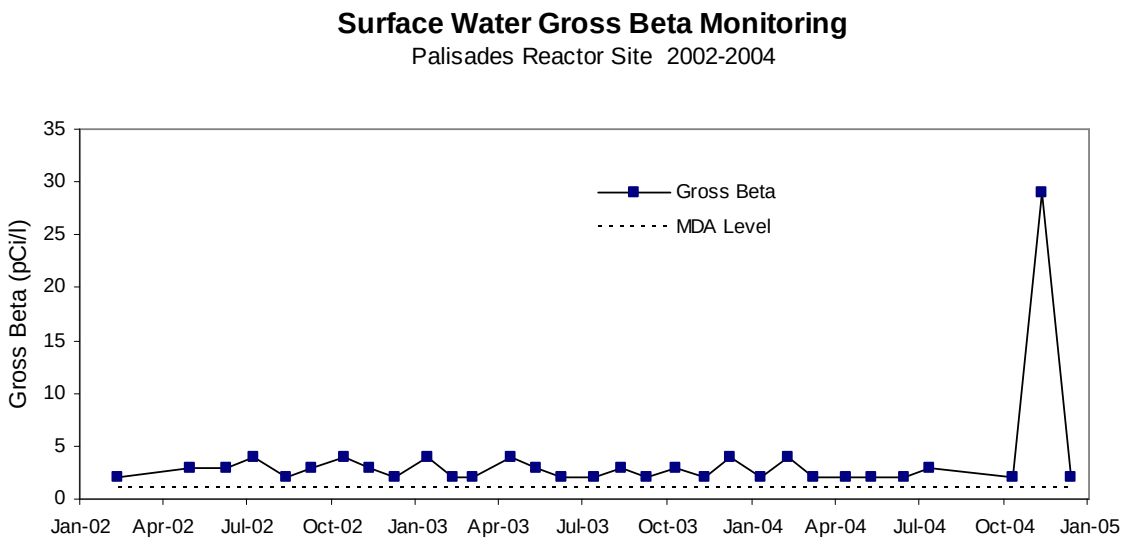


Figure 26

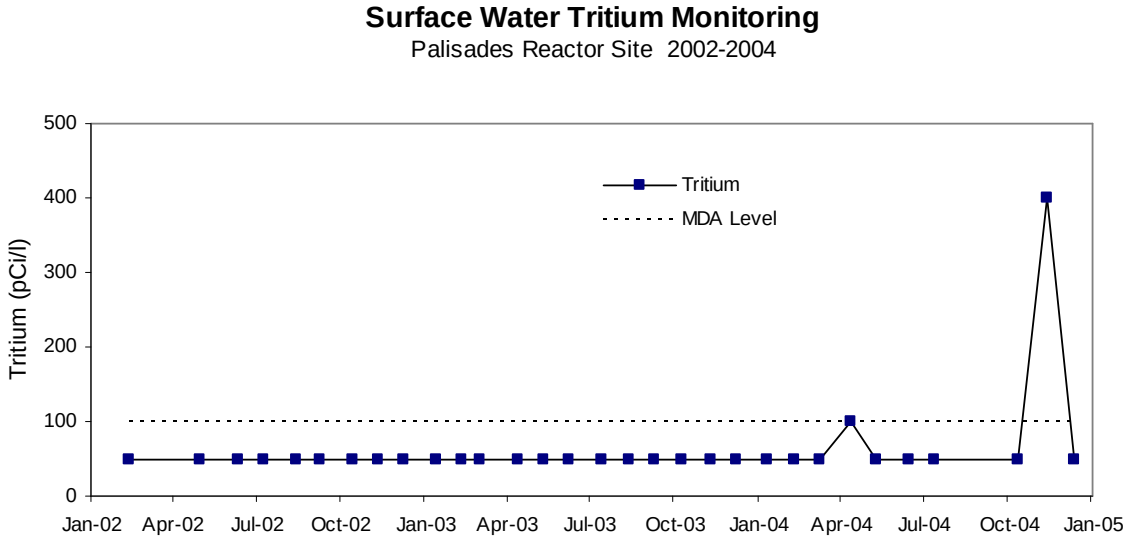


Figure 27

Surface Water Gross Beta Monitoring

D. C. Cook 1 Reactor Site 2002-2004

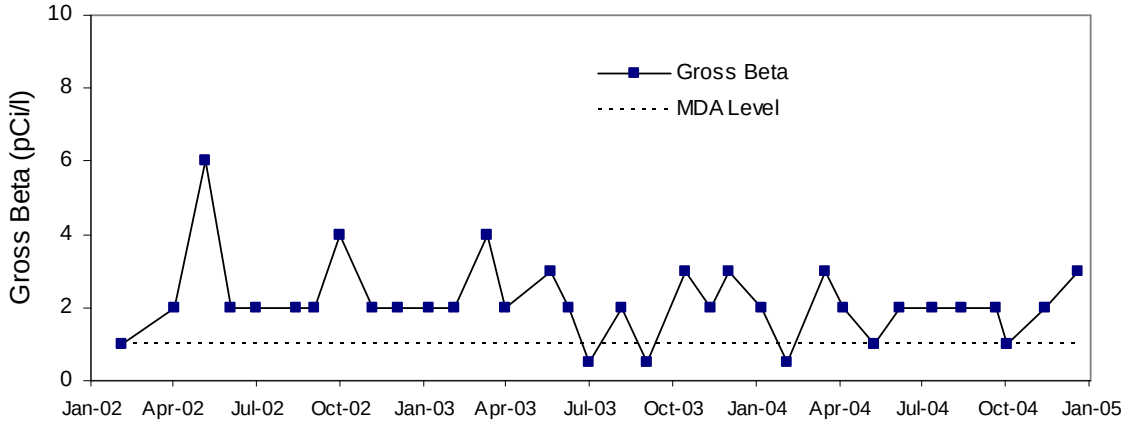


Figure 28

Surface Water Tritium Monitoring

D. C. Cook 1 Reactor Site 2002-2004

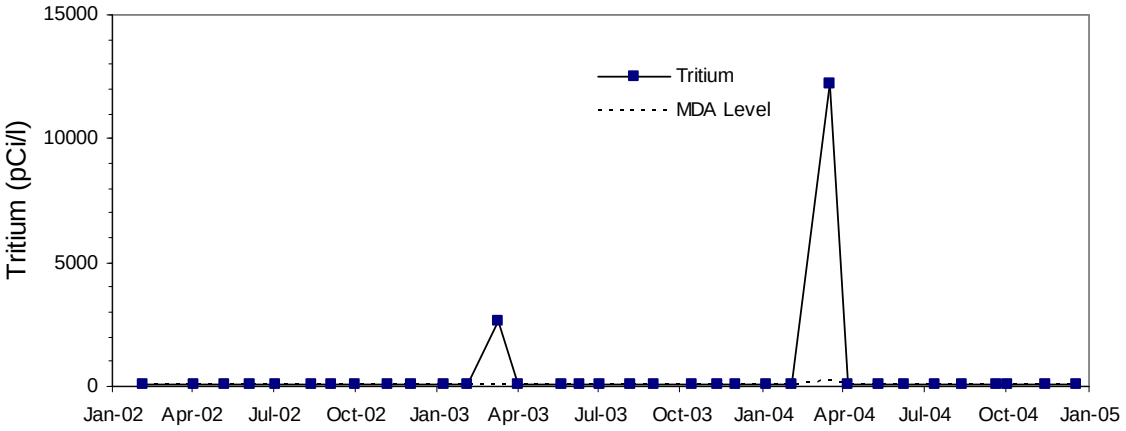


Figure 29

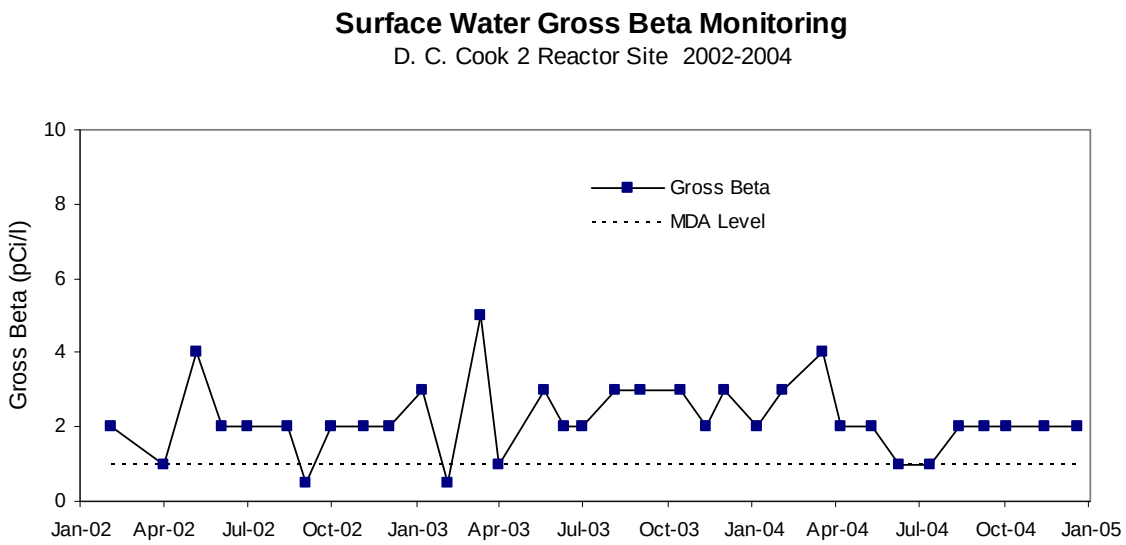


Figure 30

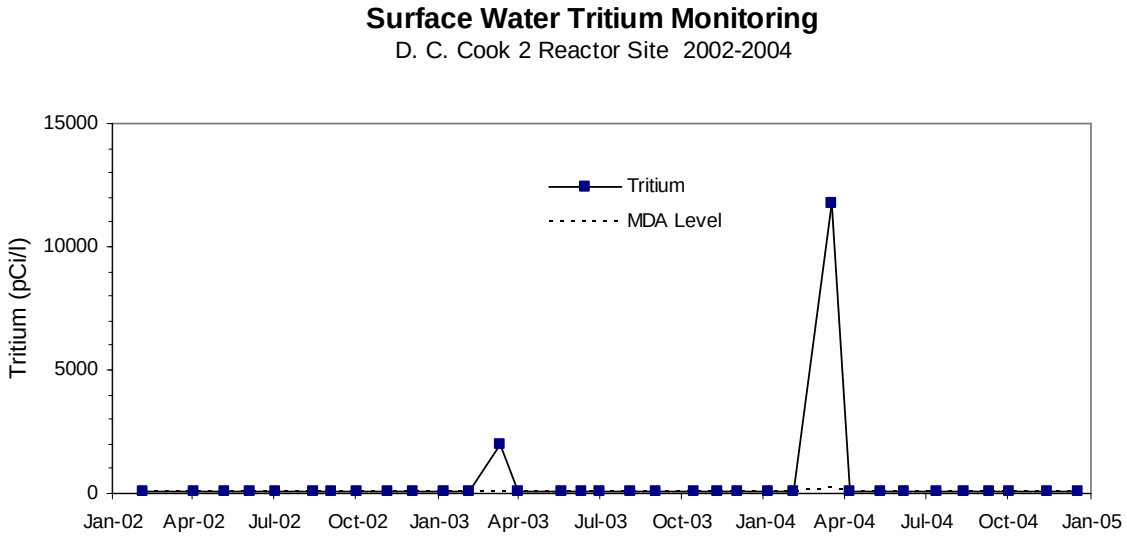


Figure 31

Surface Water Gross Beta Monitoring

Fermi 2 Reactor Site 2002-2004

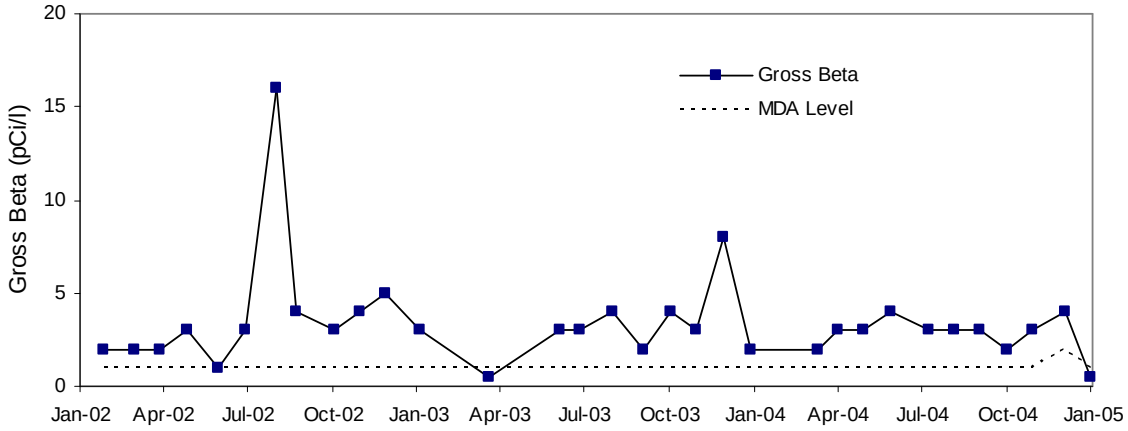


Figure 32

Surface Water Tritium Monitoring

Fermi 2 Reactor Site 2002-2004

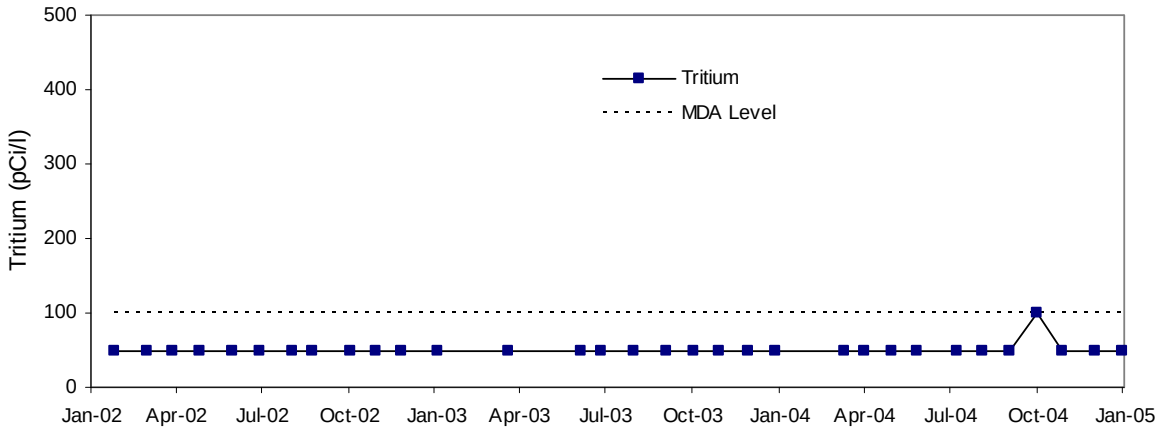


Figure 33

Surface Water Gross Beta Monitoring

Fermi 2 Monroe Intake Site 2002-2004

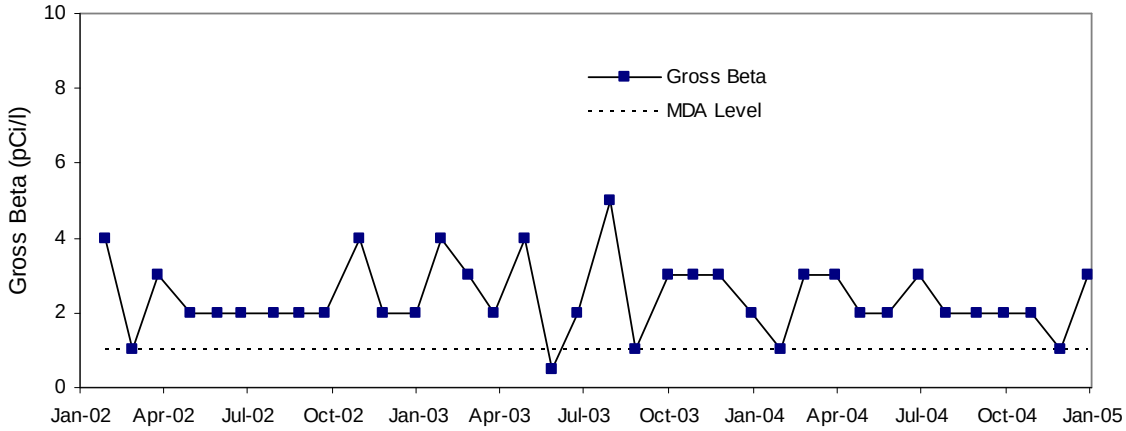


Figure 34

Surface Water Tritium Monitoring

Fermi 2 Monroe Intake Site 2002-2004

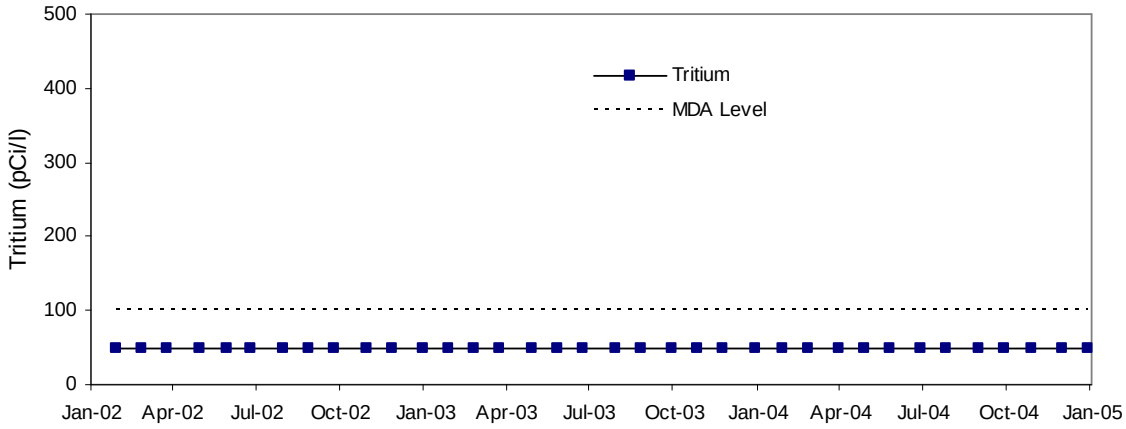


Figure 35

Surface Water Gross Beta Monitoring

Fermi 2 Trenton Channel Site 2002-2004

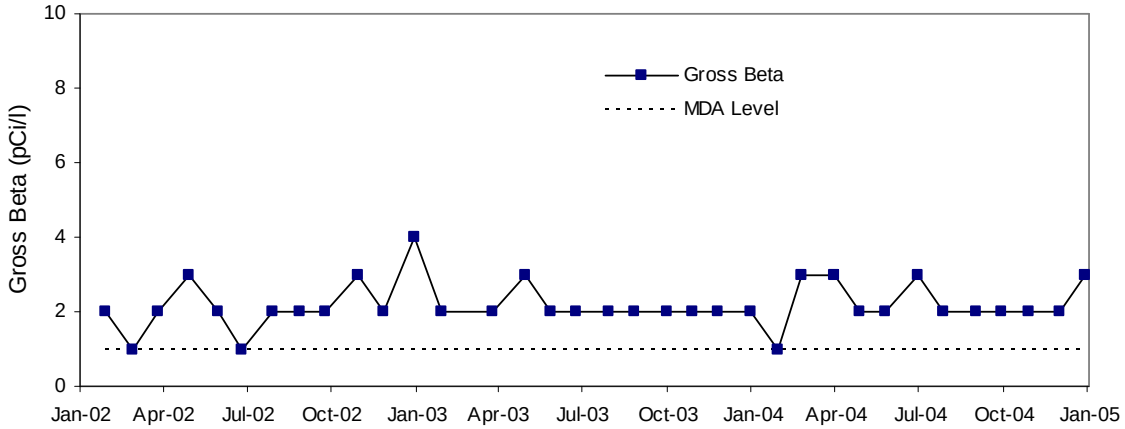


Figure 36

Surface Water Tritium Monitoring

Fermi 2 Trenton Channel Site 2002-2004

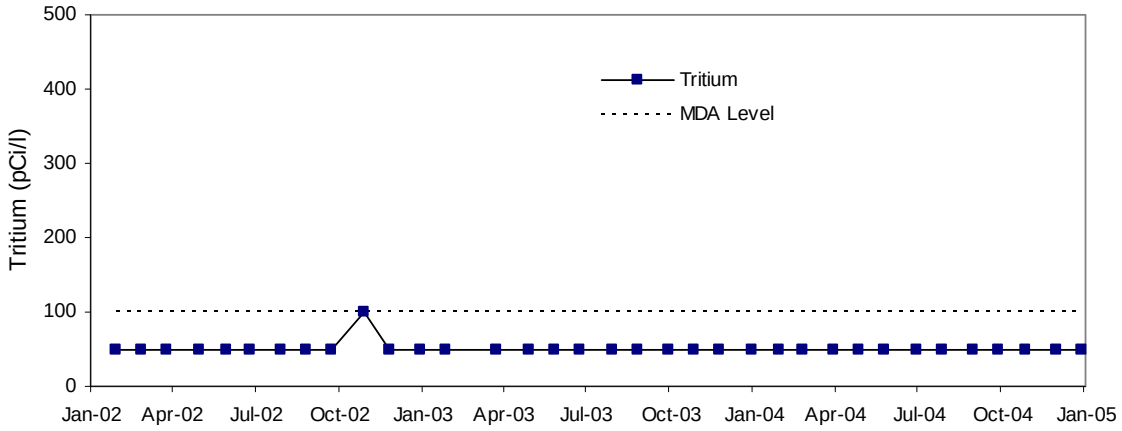


Figure 37

Surface Water Gross Beta Monitoring
Fermi 2 Allen Park Intake Site 2002-2004

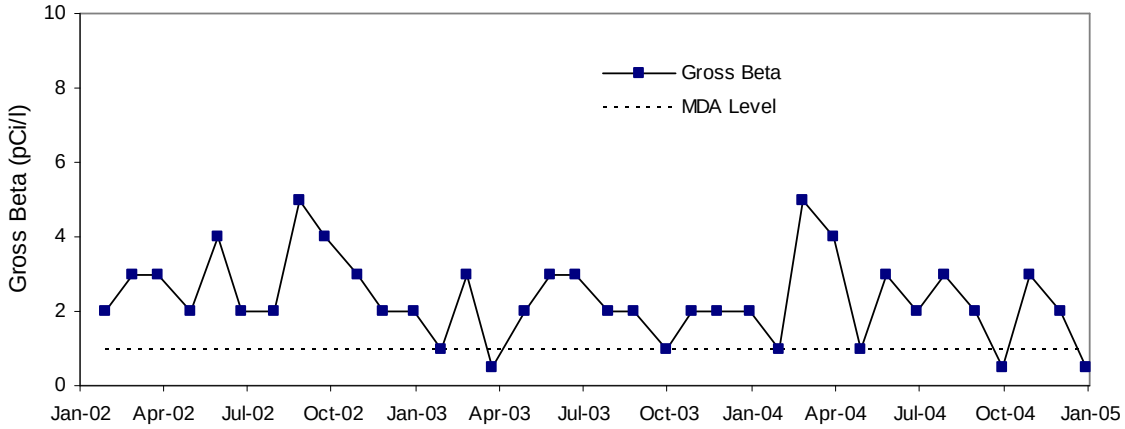


Figure 38

Surface Water Tritium Monitoring
Fermi 2 Allen Park Intake Site 2002-2004

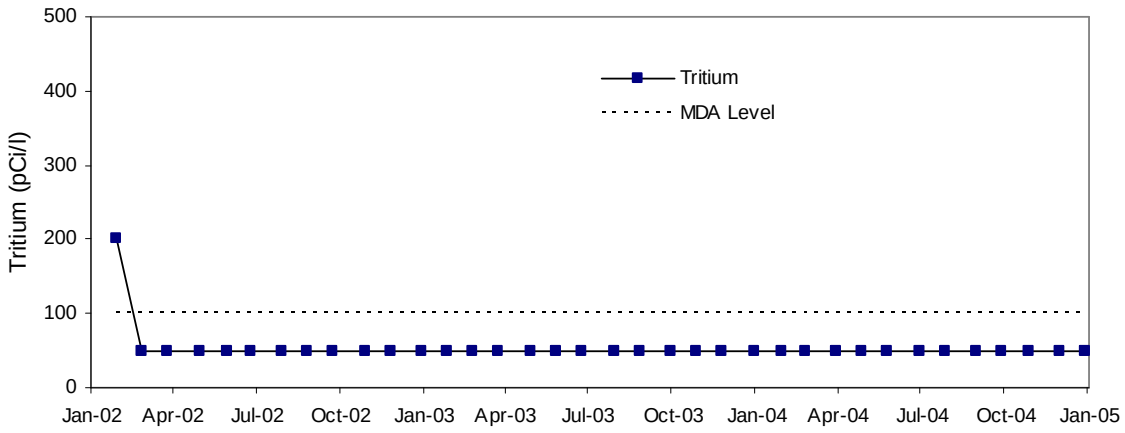


Figure 39

Surface Water Gross Beta Monitoring

Fermi 2 Intake Site 2002-2004

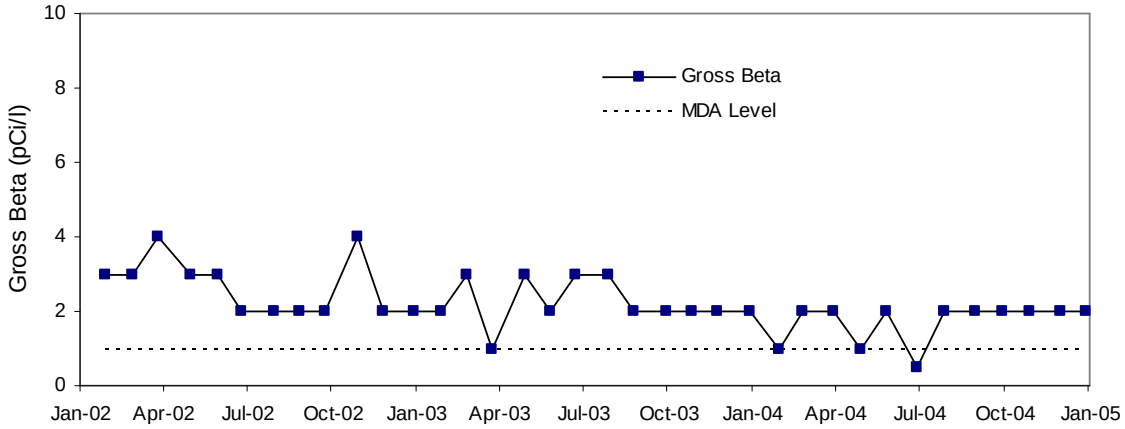
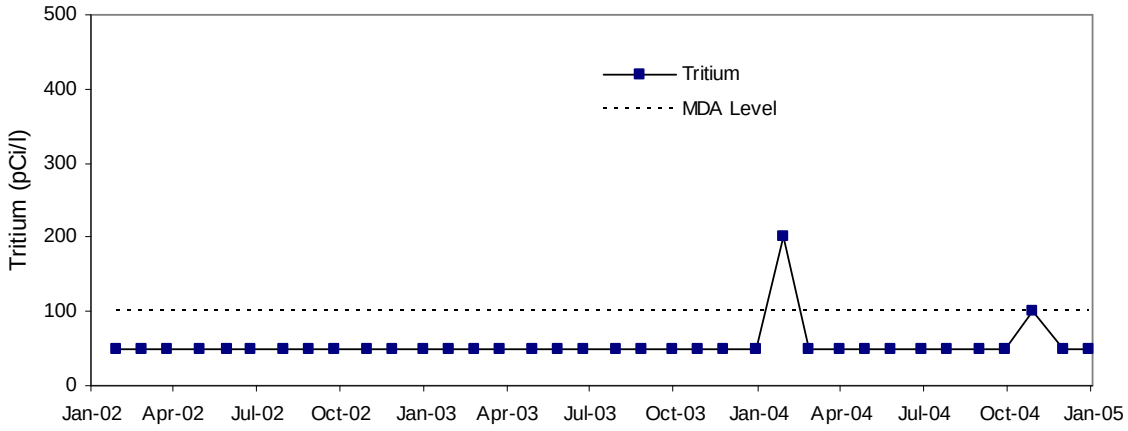


Figure 40

Surface Water Tritium Monitoring

Fermi 2 Intake Site 2002-2004



DIRECT RADIATION MONITORING

Sampling Network

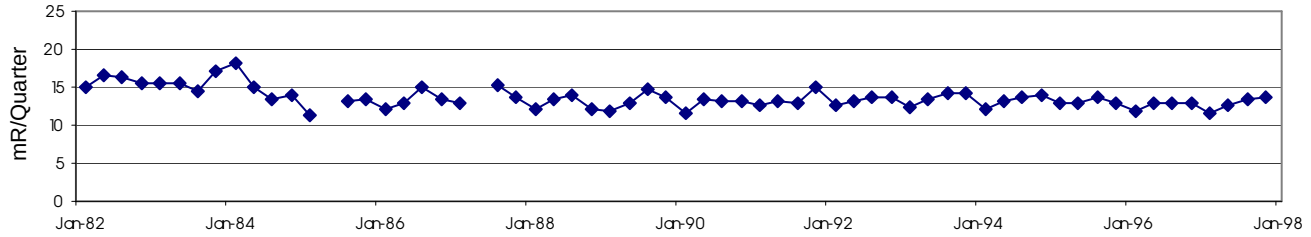
The direct radiation monitoring network consists of 12 to 16 monitoring sites for the four power plant areas and a background reference site in Lansing. The network thermoluminescent dosimeters (TLD) are exchanged and analyzed each calendar quarter by MDEQ staff. This direct radiation monitoring network replaces the NRC network which was discontinued in 1997. Direct radiation monitoring results are reported in units of milliroentgens (mR) per quarter or, equivalently, mR per 90 days.

Historical Direct Radiation Monitoring Trends

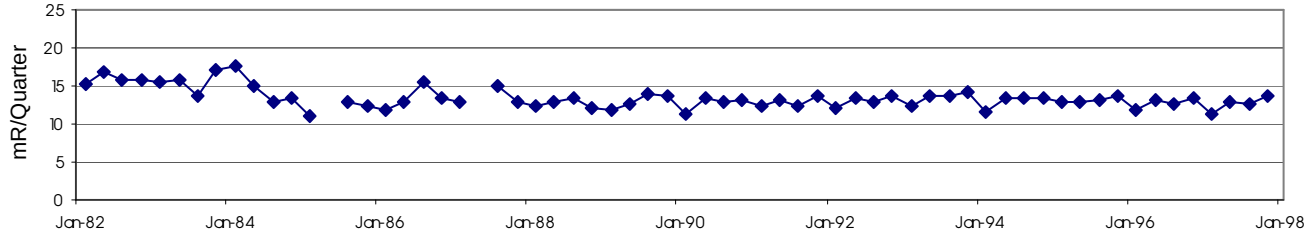
The NRC quarterly direct radiation monitoring program was initiated in the early 1980s around Michigan's four nuclear plant sites and was in operation through the end of 1997. A detailed discussion of historical direct radiation results and trends for the NRC network of monitoring sites was presented in the *MREMP Report 1958-1996*. These detailed discussions are not repeated in this report, but the historical plots of quarterly direct radiation results are shown in Figures 41-44. Since the MDEQ network of monitoring sites uses only some of the locations used in the NRC network, the 2002-2004 monitoring results are not included in these historical plots.

Figure 41

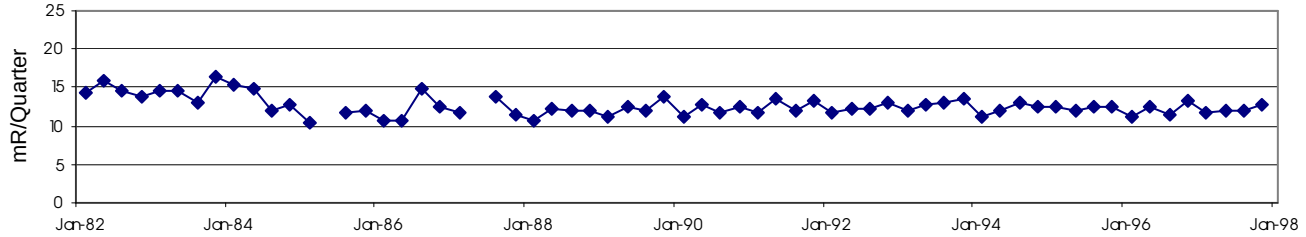
Direct Radiation Monitoring
Big Rock Point Plant (0-2 Miles)



Direct Radiation Monitoring
Big Rock Point Plant (2-5 Miles)



Direct Radiation Monitoring
Big Rock Point Plant (>5 Miles)



Direct Radiation Monitoring
Big Rock Point Plant (Upw ind Control)

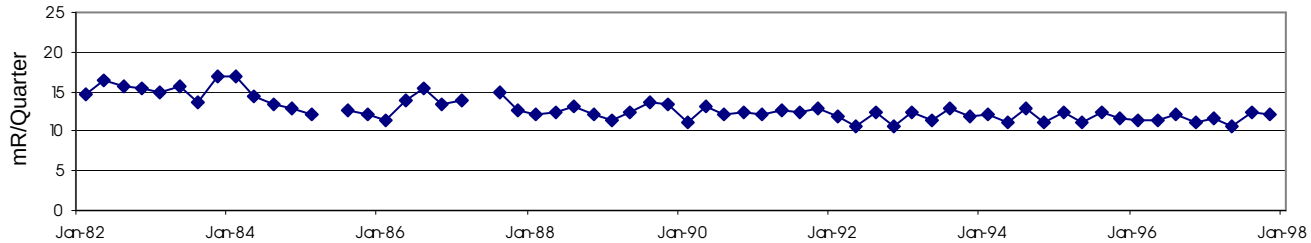
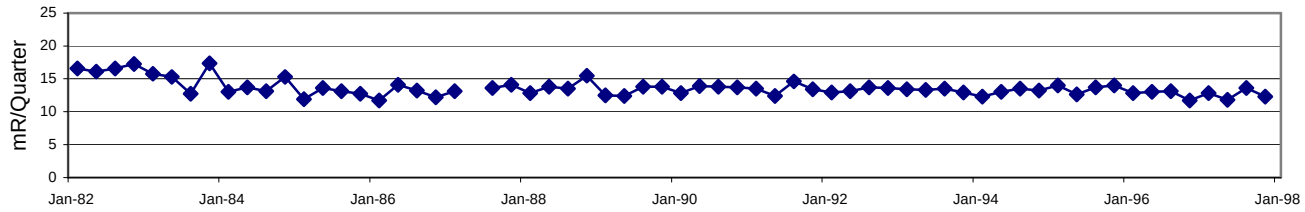
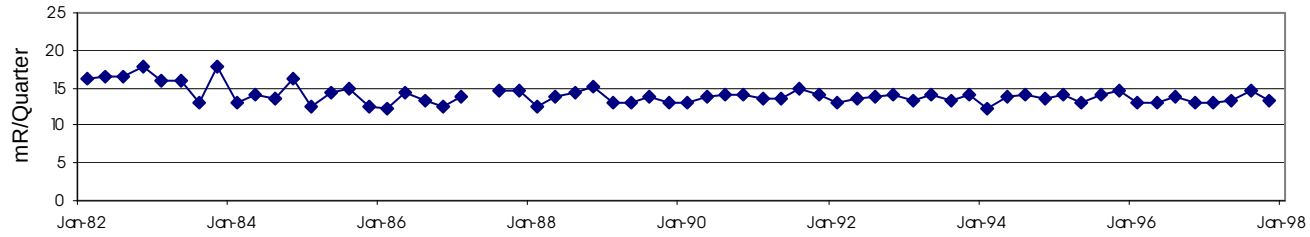


Figure 42

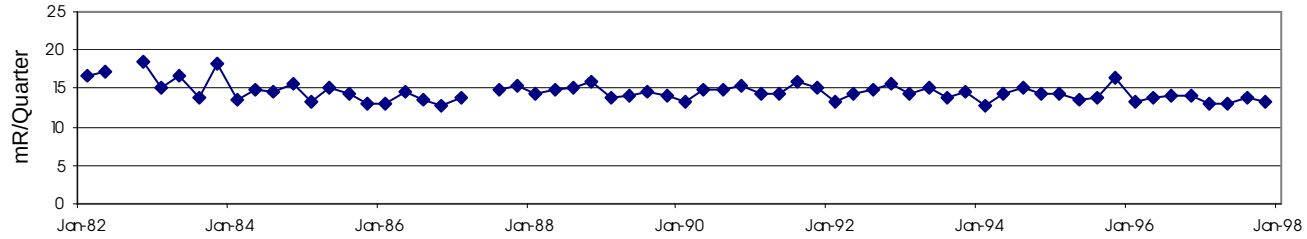
Direct Radiation Monitoring
Palisades Plant (0-2 Miles)



Direct Radiation Monitoring
Palisades Plant (2-5 Miles)



Direct Radiation Monitoring
Palisades Plant (>5 Miles)



Direct Radiation Monitoring
Palisades Plant (Upwind Control)

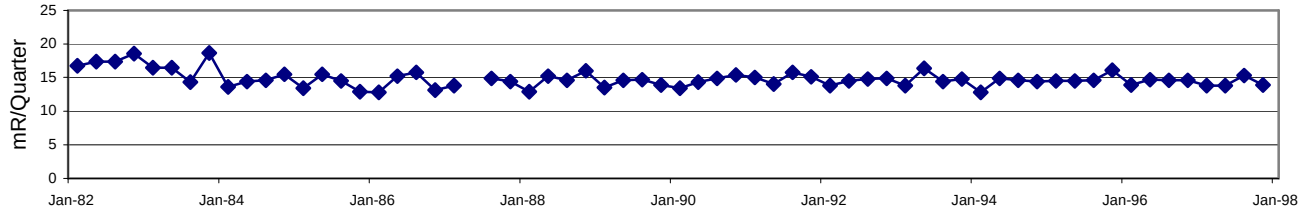
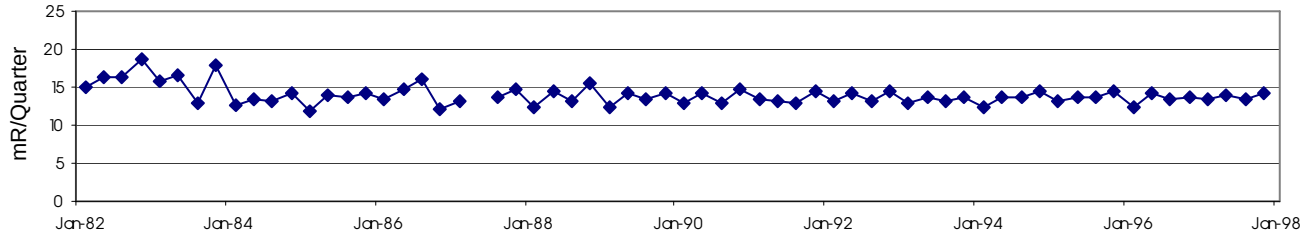


Figure 43

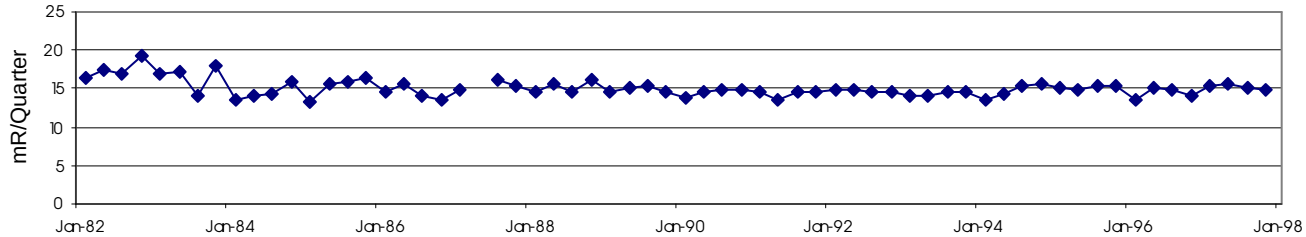
Direct Radiation Monitoring

D. C. Cook Plant (0-2 Miles)



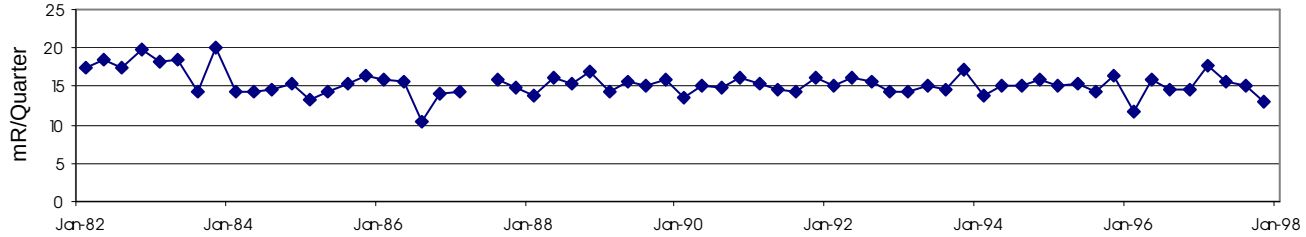
Direct Radiation Monitoring

D. C. Cook Plant (2-5 Miles)



Direct Radiation Monitoring

D. C. Cook Plant (>5 Miles)



Direct Radiation Monitoring

D. C. Cook Plant (Upw ind Control)

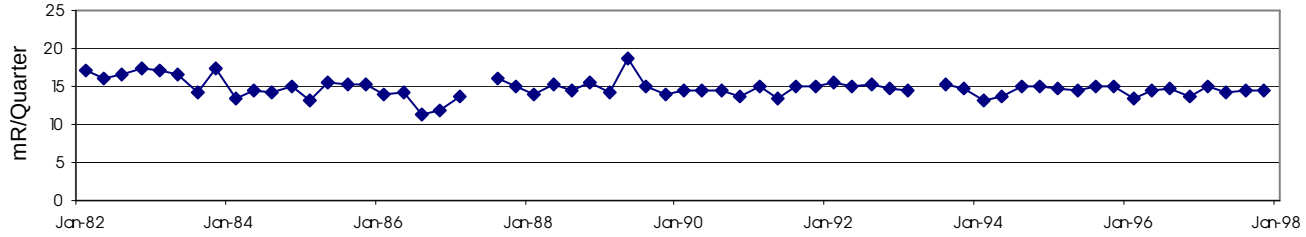
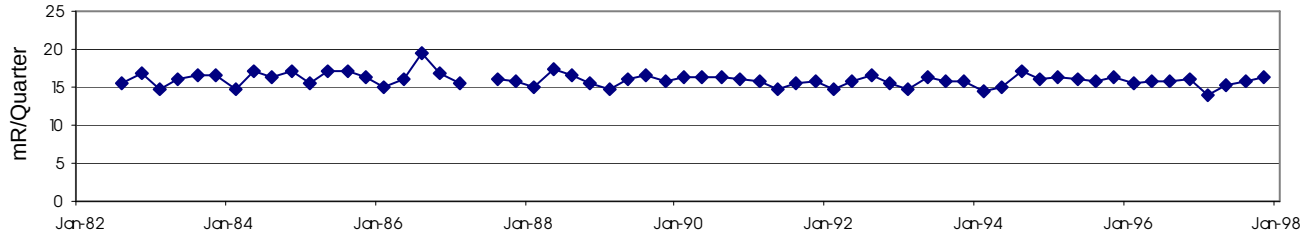
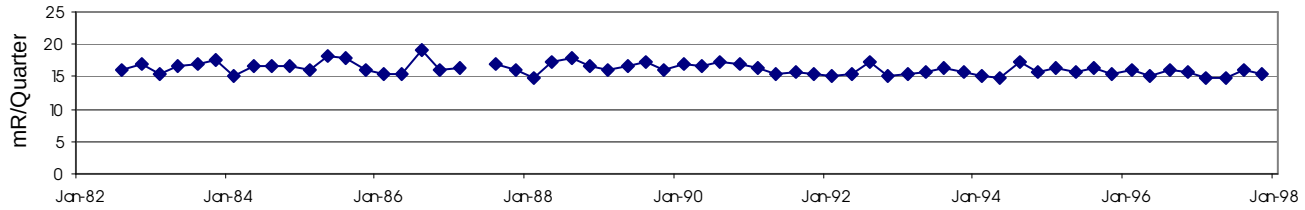


Figure 44

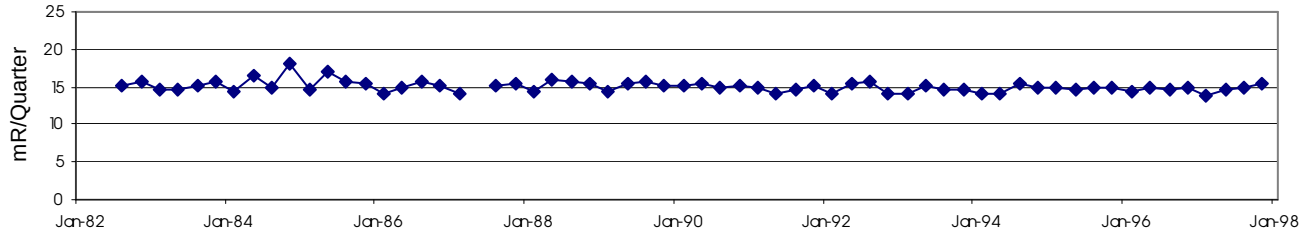
Direct Radiation Monitoring
Fermi 2 Plant (0-2 Miles)



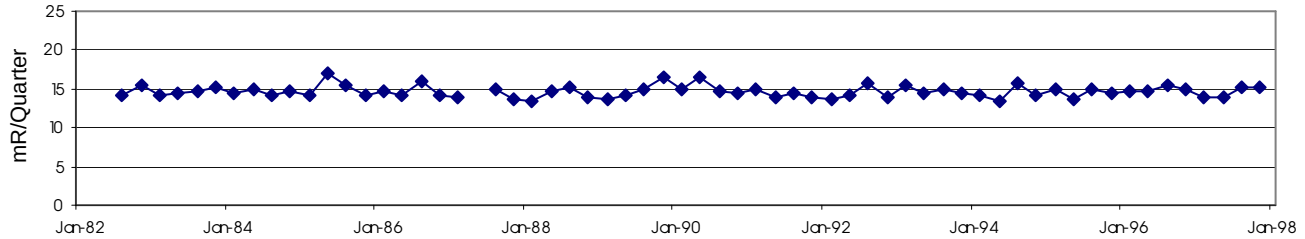
Direct Radiation Monitoring
Fermi 2 Plant (2-5 Miles)



Direct Radiation Monitoring
Fermi 2 Plant (>5 Miles)



Direct Radiation Monitoring
Fermi 2 Plant (Upw ind Control)



Direct Radiation Monitoring 2002-2004

During June and July of 1998, a replacement network of direct radiation monitoring sites was established around the four Michigan nuclear power plants along with a background reference site in Lansing, Michigan. The new network of monitoring sites around each of the four nuclear plants is very similar to the NRC network, with a couple of changes. A new monitoring site was co-located with the MDEQ air sampler, near the reactor at each of the nuclear power plants so to have a site actually on plant property. In late 2001, monitoring commenced at the Big Rock Point Interim Spent Fuel Storage Installation (ISFSI) with dosimeters placed at the four corners of the fenced area. The monitoring network surrounding the Big Rock Point Plant was reduced from 12 off-site monitoring sites to 7, due to the progress in plant decommissioning. Also, less monitoring sites are used in the area surrounding each of the plants and the NRC upwind control sites were eliminated. A total of 59 monitoring sites (12 for Big Rock Point, 15 for Palisades, 15 for D. C. Cook, 16 for Fermi 2, and 1 for Lansing) are used in the new MREMP direct radiation network. The TLDs are exchanged at the 59 sites every quarter, analyzed, and the results normalized to a standard 90 day calendar to facilitate comparison over time.

In September 2002, the 25 year-old TLD reader malfunctioned, and due to the unavailability of replacement parts, it was retired from service. A new TLD reader was ordered and became operational in June 2003. Due to the unavailability of a TLD reader for the nine months, the third quarter 2002 dosimeters were left in place for one year (Quarters 3 & 4, 2002 and Quarters 1 & 2, 2003). The year long measurements were converted to mR/quarter and were in very good agreement with quarterly measurements taken before and after the TLD reader replacement.

Details of the 2002-2004 direct radiation monitoring results for each of the four plants with a comparison to the Lansing background reference site results are discussed below. Figures 45-48 at the end of this section show the quarterly exposure measurement results as a function distance and Figures 49-52 show the average quarterly exposure measurement results as a function of direction for each plant. A tabular presentation of the measurements results for 2002-2004 is presented in Appendix D.

Big Rock Point

Direct radiation results during 2002-2004 monitoring period were, on the average, consistent with previous monitoring years. The average of all measurements taken at the eight plant network monitoring sites during 2002-2004 was 13.2 mR, which is considerably lower than the average of 18.6 mR for the Lansing background reference site. Averaging the quarterly monitoring measurements for the ISFSI resulted in a three-year average of 10.1 mR, which is somewhat less than the plant monitoring network three-year average. The 2002-2004 average quarterly results as a function of distance and compass direction from the plant and the ISFSI results are presented in Table 22. Note that the average quarterly results for the reactor site (0 miles) are considerably higher than other average results. This is due to the dosimeter being located near the radiological waste processing building, where decommissioning and radioactive waste shipment loading activities are taking place. Other than the higher result just mentioned, no unusual trends are exhibited as a function of distance or direction from the plant as shown in Figures 45 and 49.

Table 22
BIG ROCK POINT DIRECT RADIATION RESULTS 2002-2004

Distance From the Plant (miles)	Average Quarterly Exposure (mR)
0	16.2
0-2	12.7
Compass Direction (22.5° Sector)	**Average Quarterly Exposure (mR)**
E	13.6
ESE	12.7
SE	13.6
SSE	12.3
S	13.2
SSW	12.6
SW	11.1
Interim Spent Fuel Storage Installation Corner Direction	**Average Quarterly Exposure (mR)**
NW	7.9
SW	11.3
SE	12.0
NE	9.4

Palisades

The average of all direct radiation measurements taken during 2002-2004 at the 15 monitoring sites in the Palisades Plant environs was 14.6 mR, much lower than the average of 18.6 mR for the Lansing background reference site. Average quarterly direct radiation levels as a function of distance and compass direction from the plant are presented in Table 23. From the information in this table and graphically shown in Figures 46 and 50, no unusual trends are exhibited as a function of either distance or compass direction from the plant.

Table 23
PALISADES DIRECT RADIATION RESULTS 2002-2004

Distance From the Reactor (miles)	Average Quarterly Exposure (mR)
0	19.5
0-2	13.6
2-5	14.8
>5	15.3
Compass Direction (22.5° Sector)	Average Quarterly Exposure (mR)
NNE	15.4
NE	16.9
ENE	13.7
E	14.3
ESE	14.2
SE	13.5
SSE	15.6
S	12.9
SSW	12.8

D. C. Cook

The average of all the quarterly direct radiation measurements taken during 2002-2004 at the 15 D. C. Cook monitoring sites was 14.4 mR, and considerably less than the 18.6 mR average for the Lansing background reference monitoring site. Average quarterly direct radiation levels as a function of distance and compass direction from the plant are presented in Table 24. From the information in this table and graphically shown in Figures 47 and 51, no unusual trends are exhibited as a function of either distance or compass direction from the plant.

Table 24
D. C. COOK DIRECT RADIATION RESULTS 2002-2004

Distance From the Reactor (miles)	Average Quarterly Exposure (mR)
0	18.5
0-2	13.5
2-5	14.9
>5	14.4
Compass Direction (22.5° Sector)	Average Quarterly Exposure (mR)
NNE	14.2
NE	12.5
ENE	13.5
E	13.3
ESE	15.7
SE	14.6
SSE	15.4
S	13.7
SSW	13.1

Fermi 2

The Fermi 2 Plant NRC quarterly TLD results for the 2002-2004 period were, on the average, the highest of the four plants which is consistent with past monitoring. The average of all measurements taken at the 16 Fermi 2 monitoring sites is 16.7 mR. Average quarterly direct radiation levels as a function of distance and compass direction from the plant are presented in Table 25. From the information in this table and graphically shown in Figures 48 and 52, no unusual trends are exhibited as a function of either distance or compass direction from the plant.

Table 25
FERMI 2 DIRECT RADIATION RESULTS 2002-2004

Distance From the Reactor (miles)	Average Quarterly Exposure (mR)
0	20.9
0-2	16.6
2-5	17.4
>5	15.6
Compass Direction (22.5° Sector)	**Average Quarterly Exposure (mR)**
N	16.2
NNE	18.8
NE	
S	16.5
SSW	14.8
SW	14.5
WSW	14.9
W	16.3
WNW	16.6
NW	15.2
NNW	17.6

Figure 45

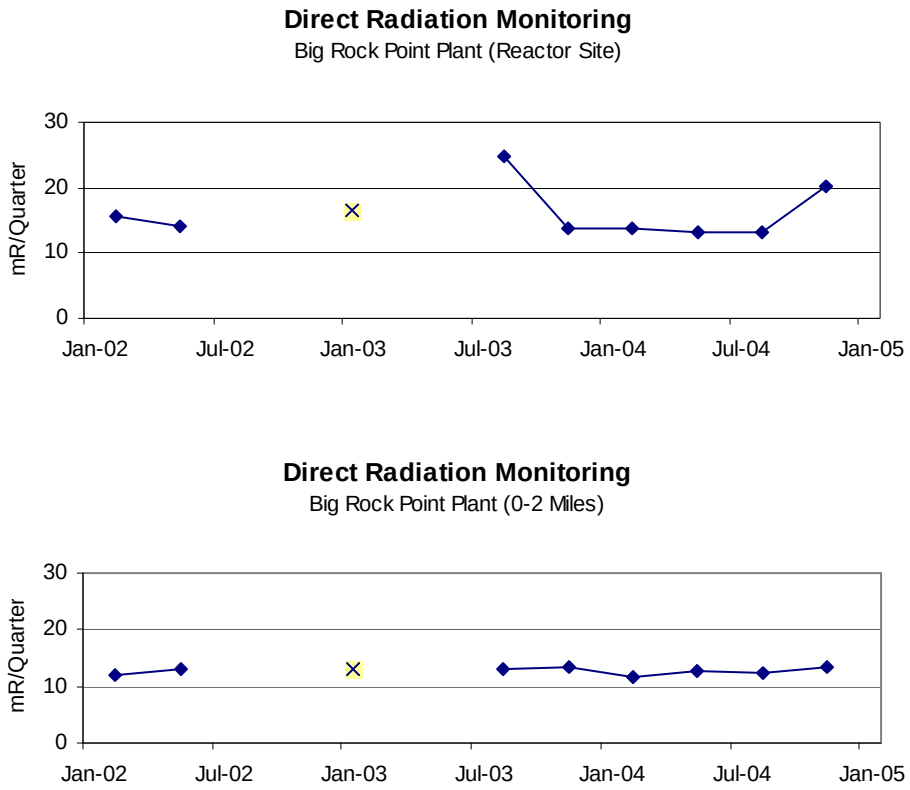
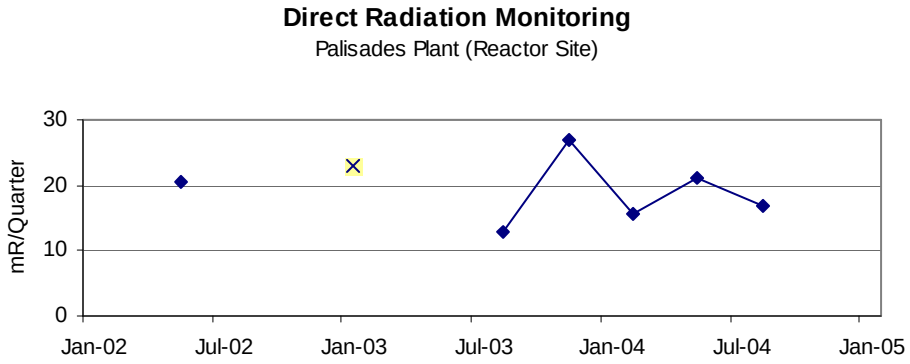
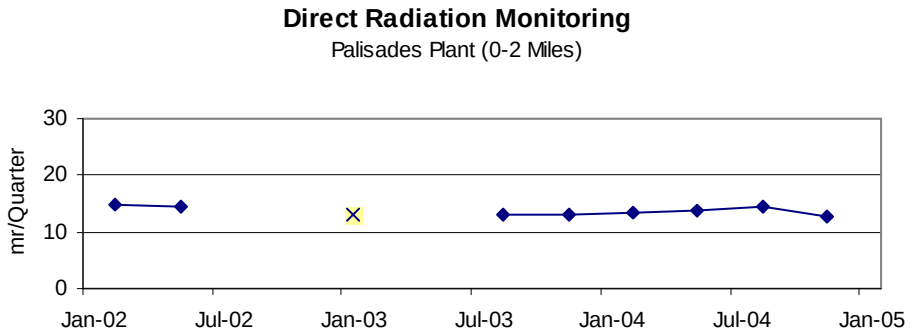
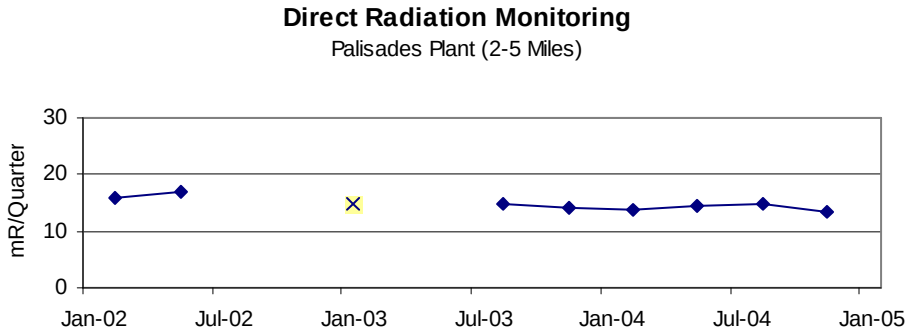

Direct Radiation Monitoring
Big Rock Point Plant (Reactor Site)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Direct Radiation Monitoring
Big Rock Point Plant (0-2 Miles)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

Figure 46


Direct Radiation Monitoring
Palisades Plant (Reactor Site)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Direct Radiation Monitoring
Palisades Plant (0-2 Miles)
mr/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Direct Radiation Monitoring
Palisades Plant (2-5 Miles)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

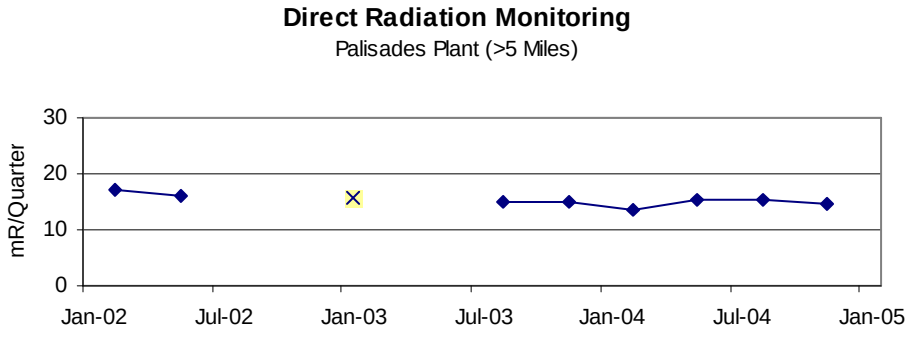
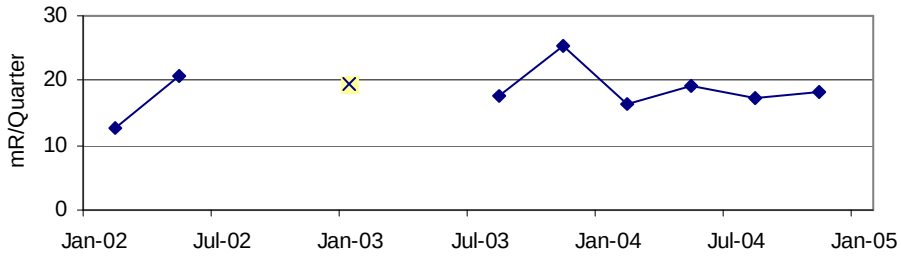
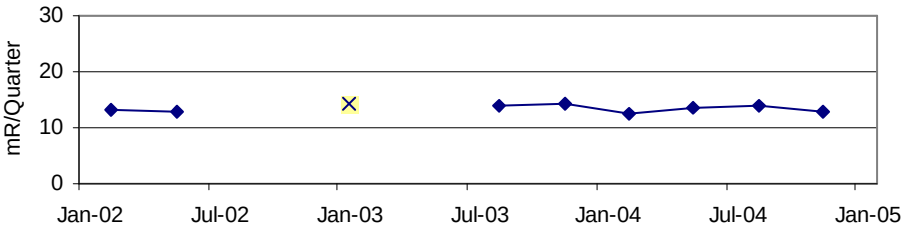

Direct Radiation Monitoring
Palisades Plant (>5 Miles)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

Figure 47

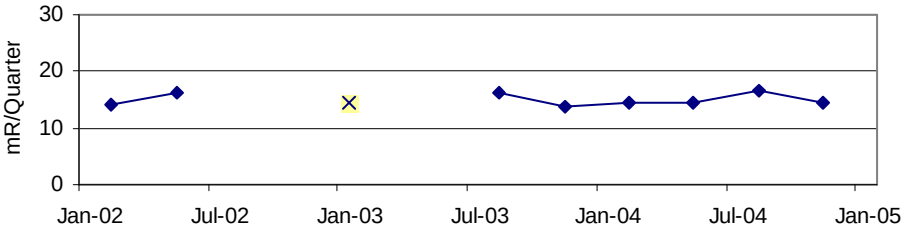
Direct Radiation Monitoring
D. C. Cook Plant (Reactor Site)



Direct Radiation Monitoring
D. C. Cook Plant (0-2 Miles)



Direct Radiation Monitoring
D. C. Cook Plant (2-5 Miles)



Direct Radiation Monitoring
D. C. Cook Plant (>5 Miles)

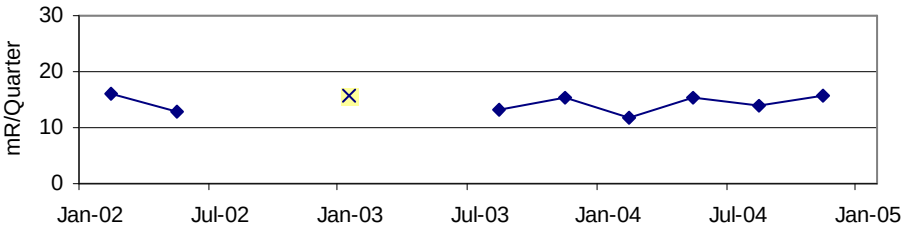
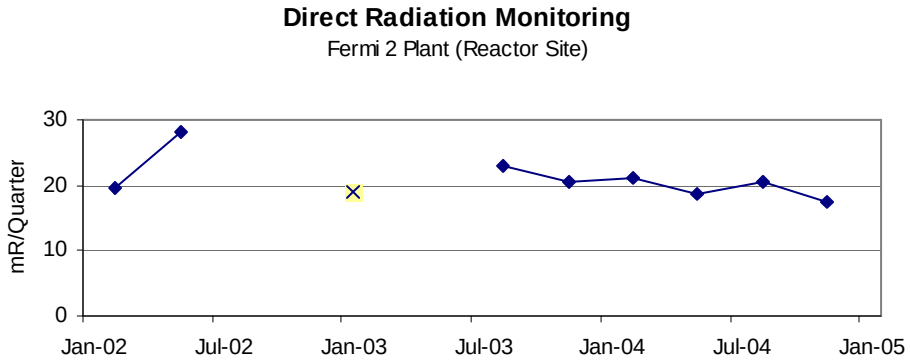
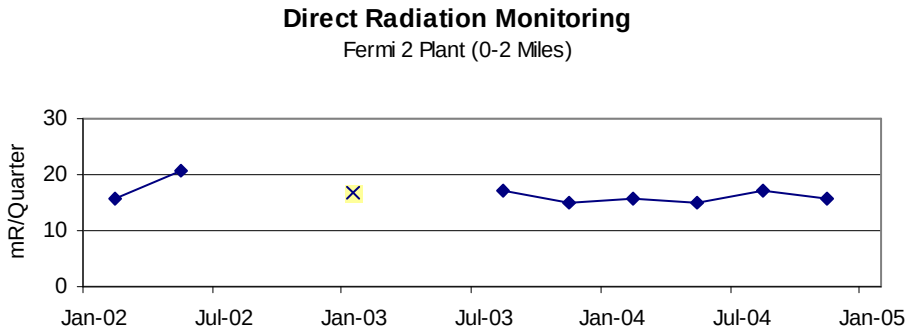
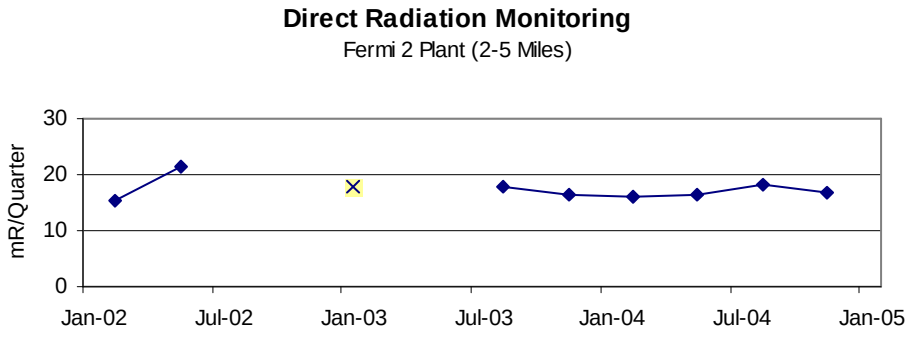


Figure 48


Direct Radiation Monitoring
Fermi 2 Plant (Reactor Site)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Direct Radiation Monitoring
Fermi 2 Plant (0-2 Miles)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Direct Radiation Monitoring
Fermi 2 Plant (2-5 Miles)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

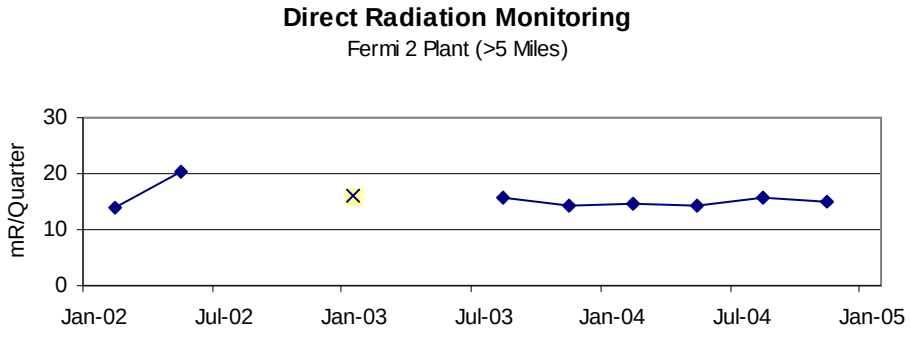

Direct Radiation Monitoring
Fermi 2 Plant (>5 Miles)
mR/Quarter
30
20
10
0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

Figure 49

Direct Radiation Monitoring
Big Rock Point Plant 2002-2004

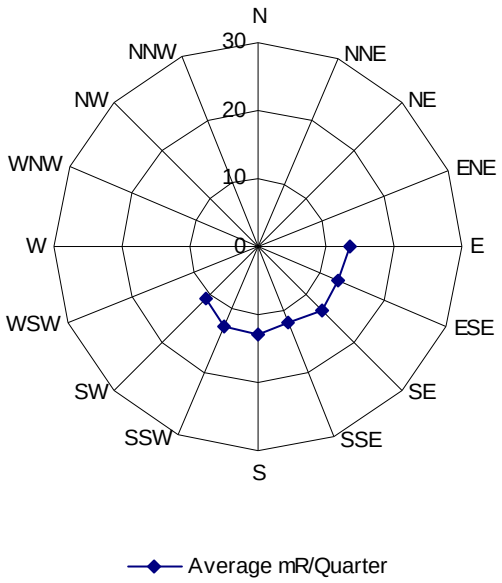


Figure 50

Direct Radiation Monitoring
Palisades Plant 2002-2004

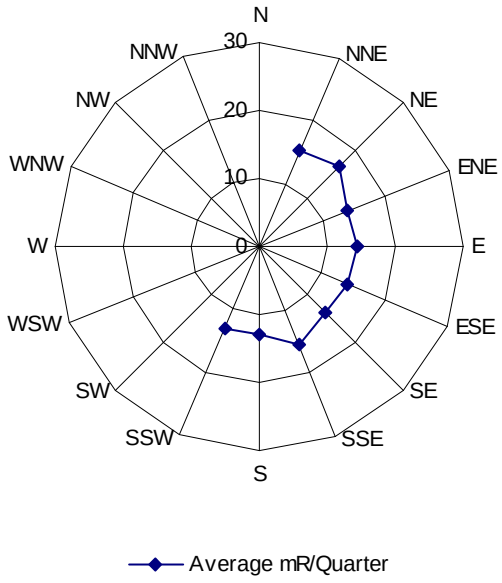


Figure 51

Direct Radiation Monitoring
D. C. Cook Plant 2002-2004

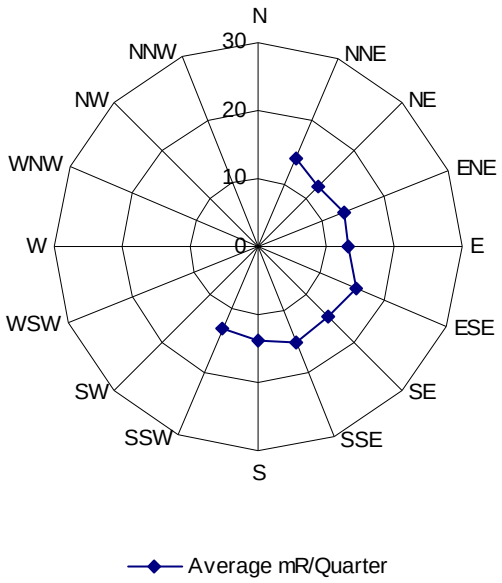
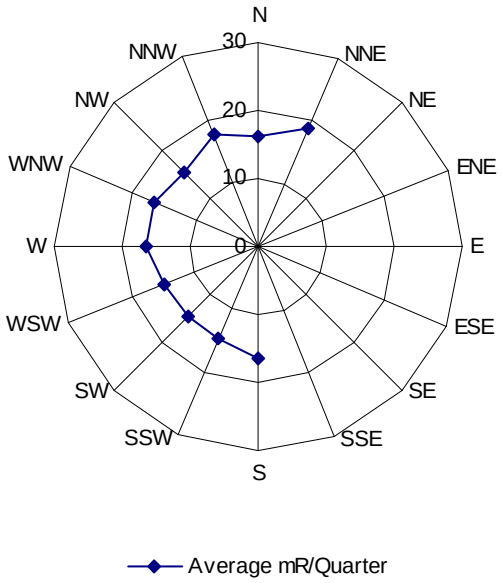


Figure 52

Direct Radiation Monitoring
Fermi 2 Plant 2002-2004



SUMMARY AND CONCLUSION

Recognizing that the peaceful use of nuclear energy to produce electricity could have an adverse impact on public health and the environment, the state of Michigan established the Michigan Radiation Environmental Monitoring Program (MREMP) in 1958. The purpose of the program is to monitor the environs near the nuclear power plant sites to assure that Michigan's citizens and its environment are not adversely impacted. Environmental samples in the form of air particulates, air vapors, milk, surface water, and direct radiation are taken from various sites in Michigan and analyzed to determine if any radiological effects due to nuclear power plants can be detected.

Geographic variations in atmospheric air particulate monitoring are evident during the 2002-2004 monitoring period. Air particulate sample analytical results were not found to be indicative of nuclear power plant operations but reflected only the normal fluctuations in natural background. Atmospheric air vapor results for the 2002-2004 period were all less than the MDA also indicating no detectable influence from nuclear power plant operations.

Terrestrial milk sample results were consistently below MDA levels during the three-year monitoring period. Long-lived radionuclides due to atmospheric fallout from nuclear device testing prior to 1981 were still present in a small percentage of milk samples, but the detectable levels found during the 2002-2004 period were only slightly above analytical MDA levels. None of the 2002-2004 milk results were attributable to Michigan nuclear plant operations

The majority of aquatic monitoring surface water sample results during 2002-2004 continued the trend of exhibiting the fluctuation in natural background from the early 1980s to the present. There were, however, a couple of samples with higher than usual gross beta activity and four samples with much higher than usual amounts of tritium activity. These samples represent a very small fraction of the total samples analyzed and were within allowable limits.

Direct radiation monitoring results have detected the impact of nuclear plant operations but only at the plant site very near to the reactor. Off-site direct radiation monitoring has historically shown levels reflecting the natural background of cosmic and terrestrial radiation. Direct radiation levels during 2002-2004 follow the normal natural background trend with no pattern that would indicate an adverse impact due to nuclear power plant operations.

In conclusion, the results of the MREMP indicate that no public health or environmental radiological impact was detected in the off-site environs of Michigan's nuclear power plants during the 2002-2004 period that could be attributed to the operation of nuclear power reactors.